BHARATIYA JYOTISH SASTRA

BY

SANKAR BALAKRISHNA DIKSHIT

PART I

History of Astronomy during the Vedic and Vedanga periods



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English Translation of BHARATIYA JYOTISH SASTRA

(History of Indian Astronomy)

by

Sankar Balakrishna Dikshit

[Translated by Prof. R. V. Vaidya, M. A. B. T.]

PART I

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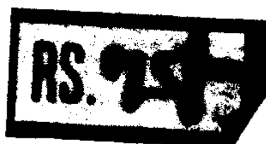
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PREFACE

In the remote past, when man first appeared on this planet, he would have looked with awe and wonder at the glory of the heavenly bodies like the sun, the moon and the stars. He would not have failed to notice that these bodies kept moving across the sky. However, centuries must have rolled by before some inquisitive and careful observers could discover that there was some periodicity in the movement of these heavenly bodies and such a rhythmic movement could be utilised to reckon time and to keep a count of the days and the months in the year. This was the beginning of Astronomy, which is one of the earliest sciences ever to be discovered in the history of mankind. When and where exactly this occurred, or it occurred at several places independently of each other, it is difficult to say now, because the early man did not have with him any means of keeping a record of his thoughts and observations. In India, which is one of the oldest civilizations in the world, we get evidence of astronomical observations as early as 4000 B. C. in the verses of the Rig-Veda and in some developed form later in the Yajur-Veda. As early as 1300 B. C. the Hindus developed a luni-solar calendar known as the Vedanga Jyotisa Calendar. This was in vogue upto the third century A. D. Thereafter, astronomy in our country took a sharp turn and a new system based on scientific principles called the Siddhantic system came into prominence. This development which continued upto the 12th century A. D. came to a standstill due to continued foreign invasions thereafter. The great epics, the Ramayana and the Mahabharata, contain some astronomical knowledge in a rather rudimentary form. Puranas which are works of a later period contain astronomical knowledge in an improved form, apparently due to the influence of the Siddhantic system of Astronomy.

For a country like India, with its culture and civilization dating back to many millenia, it is essential that the achievements of earlier generations in the various fields of knowledge should be carefully unearthed and fully recorded. This history of Astronomy of the ancient and medieval periods of India falls under this category and a thorough study in this field requires to be made. But the difficulties in undertaking such a comprehensive study are enormous in that the information has to be gathered from the vast store of Sanskrit literature extending from the Vedic period upto the present time, and in our literature, the astronomical observations are not recorded in a clear-cut language but so to say have

been shrouded in allegorical language and concealed in stories and anecdotes, the full significance of which it is difficult to surmise. One such comprehensive study, perhaps the only one of its kind, has been undertaken by Shri Sankar Balakrishna Dikshit in his treatise in Marathi "Bharatiya Jyotish Sastracha Prachin Ani Arvachin Itihas " in the year 1896 and this is perhaps the only book recording the history of the Indian Astronomy from the ancient to the modern times. Late Dr. M. N. Saha, F.R.S., while working as Chairman of the Calendar Reform Committee recommended that an English translation of this excellent treatise "Bharatiya Jyotish Sastra, a history of Indian Astronomy—ancient and modern " should be published by the Government in order to facilitate Indologists, both Indian and foreign, to carry on research on Indian Astronomy. The work of the translation of this treatise from Marathi to English was gladly undertaken by Prof. R. V. Vaidya, M.A., B.T., a Marathi scholar and Superintendent of Shree Jiwaji Observatory, Ujjain and who was also a member of the Calendar Reform Committee. This translation was examined and touched up here and there by Late Prof. P. C. Sen Gupta, M.A., a renowned Professor of Hindu Astronomy of the Calcutta University. With the transfer of the entire work of the Calendar Reform Committee to the India Meteorological Department, it decided to publish this work. The final editing of the book has been done under the supervision of Shri N. C. Lahiri, M.A., Officer-in-charge of the Nautical Almanac Unit at the Meteorological Office, Alipore, Calcutta.

The book is rather voluminous and it would take considerable time to publish the whole book in one volume. Hence it has been decided to publish the book in three parts. The present volume which is Part I traces the history of Indian Astronomy in the Vedic and Vedanga period from the ancient times upto 1000 B.C. Attempts are being made to bring out the other two parts comprising of the Siddhantic period and the Modern period as early as possible.

India Meteorological Department,
Lodi Road, New Delhi.
18th April, 1968.

L. S. Mathur,
Director General of Observatories.

BHARATIYA JYOTISH SASTRA

PART I

History of Astronomy During the Vedic and Vedanga Periods

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SUMMARY OF PART ONE

TRANSLITERATION

The scheme of transliteration of Sanskrit alphabets into Roman script adopted in this publication is the same as generally followed. The corresponding scripts are given below :

अ	आ	इ	ई	उ	ऊ
a	ā	i	ī	u	ū
ऋ	लृ	ए	ऐ	ओ	औ
ṛ	ḷ	e	ai	o	ou
क्	ख्	ग्	घ्	ङ	
k	kh	g	gh	ṅ	
च्	छ्	ज्	झ्	ञ	
c	ch	j	jh	ñ	
ट्	ठ्	ड्	ढ्	ण्	
ṭ	ṭh	ḍ	ḍh	ṇ	
त्	थ्	द्	ध्	न्	
t	th	d	dh	n	
प्	फ्	ब्	भ्	म्	
p	ph	b	bh	m	
य्	र	ल्	व्	श्	
y	r	l	v	ś	
ष्	स्	ह्	ं	:	
ṣ	s	h	ṃ	ḥ	

AUTHOR'S PREFACE

The subject matter of this book has been presented in broad outline in the Introduction and a detailed idea of the subjects dealt with can be obtained from the table of contents and the subject-index at the end. I do not consider it necessary to dilate here on the utility of the book. If it be asked why the science of astronomy came into being at all, I have nothing more to say than that the science owes its origin to the natural curiosity of man. This science must have attracted the attention of man from times immemorial ; in fact, one may safely say that it is the very first science evolved by man. This being so, I do not think that any apology is required for undertaking the survey and discussion of the growth of this science in our country.

The present work has no parallel in Sanskrit literature. Our people are not much inclined to assess the merit of different works in the light of chronological sequence ; an author born a couple of centuries ago is, in their eyes, almost on a par with one who flourished a thousand years ago. Again, they are not disposed to trace the history of any science nor have they developed the habit of recording the lives of ordinary men. These appear to be some of the reasons why the like of this book was never produced in the past.

I propose to relate here in brief how the opportunity arose for writing this book. About the Śaka year 1802 I began to take interest in the question of the Sāyana Pañcāṅga and eventually in Indian astronomy. As I went on dipping into old works I was led to estimate that comparative worth, to determine the chronological order of their compilation and to study the various stages in the growth of astronomy; and I began to feel that a work of this nature would be a welcome addition to our literature. In Śaka 1806 a vigorous movement for calendar reform had been launched in this province. As a result of this the DAKṢIṆĀ PRIZE COMMITTEE of Poona published an advertisement in December 1884 for a book devoted to the consideration of the chaotic condition of our Pañcāṅgas in the light of the history of our astronomy. As I had a liking for the proposed subject I was naturally prompted to undertake the work. The prize announced for the work was Rs. 450 and the time limit prescribed for it was the end of the year 1886. But by that time I could not procure the necessary material, particularly the ancient works and it was not possible for me to begin the writing. A request was then made to the Dakṣiṇā Prize Committee to extend the time limit, which was granted. But even then nearly six months passed simply in collecting the necessary information. At last I set my hand to the task of writing in November 1887 and submitted Part I to the Committee in the beginning of 1888. Writing and the search for more material went on *pari passu*, though not without impediments. At long last I managed to present the whole work to the Committee in three instalments, by the end of October 1888. The contents of the work would have amounted to 425 printed pages of a book of this size and they included the treatment of many more subjects and in much greater detail than what the Committee had expected of me. The work was approved by the Committee and I received the full prize in 1891. Later I began to think of publishing the book ; but how could I undertake such an expensive project ? A few days later the proprietors of the Aryabhusan Press agreed to shoulder the responsibility. By this time, however, an advertisement for a treatise on Pañcāṅga was published by the *Gaikwad Government*, for which a prize of 1000 Gaikwadi rupees was announced ; accordingly I sent to the Gaikwad Govt. the relevant part of the book

in the beginning of the Śaka year 1815, i.e. in 1893 A.D. A number of people had been suggesting to me that the book should be published but to my mind it was not yet complete ; some new matter that had come to hand was to be inserted at the proper places and some more was still to be collected. Moreover, I intended to await the decision of the Gaikwad Govt. about the work already submitted.* I came over to Poona in July 1894. Many people urged me to publish the book and therefore, the proprietor of the Aryabhushan Press, commenced the printing in March 1895. While the book was in press, I went on reading old books not seen before and collecting still more information, as can be seen from the footnotes appearing at several pages of the book.

A part of the matter originally submitted to the Dakṣiṇā Prize Committee has been abridged and at times even omitted, so that the original volume which covered 425 pages has now been reduced by 40 pages ; still, the present work has grown into a volume of 524 pages. This amounts to an addition of 140 pages to the original, not to mention the index which is altogether new.

Our people have not even a faint idea at present about the wealth of astronomical knowledge and astronomical literature in our country. The knowledge of the ordinary man is confined to the names of an astronomer or two like Bhāskarācārya and at the most the titles of a few works on astronomy. This work, however, contains an account of a host of astronomers and their works; even the mere enumeration of their names covers two long lists at the beginning of the indices. The reader cannot but be astounded to see this marvellous wealth of knowledge, and as he reads the history of the growth of astronomy he will come to realize the great calibre of our ancestors from their extra-ordinary efforts, researches and curiosity and his heart will be overwhelmed with delight.

It is needless to say that being scientific the present work will not be readily intelligible to all and sundry like works of fiction. It cannot, however, be said that every section of the book will be found unintelligible. Supposing the book is divided into sections of eight pages, then every such section contains something or other equally intelligible to all readers. The reader should, therefore, not despair if some passage is found to be abstruse, but should proceed with the reading. I am sure that no reader would be found who is unable to understand even a single page of this work. One reader may understand one subject, another may understand some other. One reader may find a particular part interesting and useful while another may be able to appreciate something else. The headings printed on the left side of the page at several places would give a glimpse into the subjects under discussion. Those headings and the table of contents or a glance at the subject-index at the end will enable the reader to find out any passage or subject that he likes. At some places technical terms have been used and if their meaning is not clear they may be looked up in the Index at the end for the page numbers for which their definitions, meanings or explanations can be found. Some of the terms have been explained in my book "Jyotirvilāsa". I was particularly keen on brevity in order that the volume may not run into great length. This has led to the introduction of lengthy compound words at some places in the book ; but these can be easily understood from the context.

* The decision has been recently announced. My work has been approved and the prize awarded to me.

According to some the book has become voluminous, while others think that it has become too concise. On reading the advertisement of my book, a notable gentleman wrote to me that the proposed subjects would require at least 1000 pages. As there is truth in both the views I have chosen to adopt the *via media*. Condensation of material cannot go beyond what is already done. On the other hand, if expansion is allowed, every page of the book can grow into four pages. Brevity could no doubt be achieved by omitting some of the subjects. But in view of the fact that opportunities for the publication of a work of this nature are few and far between, I have included in this book all available information on various subjects, that seemed noteworthy in my opinion.

It is not claimed that the work is complete as it is. It has nothing to say about the astronomical references occurring in *Vālmīki's Rāmāyaṇa*. Nor does it contain anything about the astronomical references from any of the eighteen *Purāṇas*. Some people suggested the inclusion of all these. But how much can I do single handed? Again there are still several works on astronomy which I have not seen. At present the Ānandāśrama of Poona alone has about 500 books on the subject. I have seen all of them; still many of them have not been taken into account in this book. The 'Aufrecht' catalogue, referred to in this book contains the titles of about 2000 books on astronomy. How to procure them and when to read them? Nevertheless my work contains all important information found in astronomical books, as also all astronomical information available from other works. Fortunately our country can proudly boast of several learned scholars at present who are far superior to me in capability. Any of them may take up the work where I leave it. I shall feel satisfied if my labours prove useful to them at least to some extent.

Some had suggested to me that I should deal with such problems as the problems of divine incarnations like *Rāma* and *Paraśurāma* in this work; but so far I have not found reliable data that would lead up to the determination of such dates, nor do I think that they would ever be found. But one must not anticipate too much; for as the poet says, the world is wide and time is endless. The trend of my views on this question can be obtained after going through the book in its entirety. The conclusion of Part I is an attempt to determine the probable periods during which particular periods were compiled.

The question as to what subjects have been or ought to have been dealt with in this book seems to have evoked quite a variety of beliefs that this work contains tables for computing *almanacs*, that it contains different methods of calculating planet's places on the basis of any *Siddhānta* work, that it explains the theory underlying all these methods, that it also gives a method for independently computing an accurate almanac like the one computed with the help of the Nautical Almanac, that it also includes choice *Jātaka* works which would enable one to cast correct horoscopes. In short, some people seemed to believe that this work contained the very quintessence of *Jyotiṣa śāstra*—both astronomy and astrology. It is needless to say that it is impossible to incorporate all these subjects in this work. But I am glad to note that such beliefs clearly reflect a strong desire for knowledge on the part of our people.

It has already been pointed out that there is no work like this in Sanskrit literature. Some information can be found in English scattered at several places; but if it is collected together it will not amount even to one fourth of the present work.

The conclusion will show that several articles have been written in English by scholars of repute. No one had, however, treated the subject in such a comprehensive manner. It is also obvious that it was never before treated from the Indian point of view.

Every statement about the contents of old works made in this book without citing some authority is based on my reading of these works ; and I have most of such important works on astronomy in my possession. Every conclusion purporting to be the result of mathematical calculation, has been arrived at from careful calculations personally made by me and I am sure that they are correct ; still as it is human to err, some errors might have crept in through oversight. In certain cases the necessary works were not available to me for reading and I had to rely on their authors and works while writing about their contents ; in all such cases I have cited the authority for my statements at the proper places. Again, where extracts have been taken from other books bodily or in a summarized form I have cited chapter and verse for every quotation. Except for this, not a single line of this book is based or borrowed from any other book or its translation.

Members of the Dakṣiṇā Prize Committee had made a few suggestions to me for the improvement of the original work. All of them except the one for abridgement have been carried out. At some places in the original work I had severely criticized European scholars. The Committee suggested that all such severity should be entirely dispensed with. Accordingly, I have toned down all such passages, though I have maintained the main points of criticism. I cannot, however help observing here that even some of our eminent scholars look upon the verdict of Europeans as gospel truth, howsoever absurd it may be. This indicates lack of confidence in one's capability and scholarship.

Rao Bahadur M. G. Ranade suggested that controversial matters like the views of European scholars and my criticism of them should be expunged from this book and reserved for discussion in some English journals, so that the book may not become voluminous. Accordingly, I did discuss some of the questions in English journals ; still I did not feel it proper to remove the relevant portions from this book. It will be found useful by some readers at least if not all. If fortunately, this work is translated into English, this detailed exposition of my views will come to the notice of European scholars and receive proper consideration from them. A European scholar has written to me that parts of this work will have to be specially translated, if an English translation of the whole is not soon forthcoming.

I want to urge my readers in all earnestness to keep a sharp look out for ancient works. I shall feel highly grateful and equally so, our country, if any one informs me of the discovery of some works not yet seen by me. Not much account could be given in this book in respect of works compiled in such regions as Telāngānā, Drāvid and Bengal. It is desirable that people should get as much information as possible about the more importance of such works as also about works like *Nāḍigranthas*. Again, the descendants of many of the authors mentioned in these pages might be still living ; and if they impart some more information to me it will no doubt, prove useful.

As regards publicity of old works, it has been noticed that the Telāngānā and Dravidian works are not widely known in other provinces. This seems to be due to the difference of script in which they are written. The works produced in Bengal

are also not available in this province. Even then, looking to the difficulties of travel and communication in ancient times, one is really surprised to see how voluminous works could reach even the remote corners of India, how works like *Grahalāghava*, so frequently mentioned in this book, gained currency all over the country in a very short period of time, and how even mediocre works have been popularised. This wide-spread currency of books seems to be due to the fact that astronomers used to be patronised not only by Hindu Kings but also by Muslim Emperors. Moreover, it appears that most of them could count upon liberal reception from the Vidyāpiṭha (Academy) at Varanasi.

It is true that the number of works on astronomy is enormous. As however ours is a very extensive country, a multiple of works devoted to the same subject of every day use were compiled in different provinces. Again, some works, specially the *Karaṇa* works, became obsolete and useless in course of time, which also gave rise to different works in different ages ; further, several people appear to have compiled several works on the same subject because it depends more or less on the ingenuity of the author or whether his work would be found to be perspicuous or not. These are some of the reasons for the multiplicity of astronomical works and their wide-spread currency.

The Vedic *mantras* or Sanskrit verses have been frequently quoted in this book. If a full translation of all these is given, it would mean an increase in size. It has, therefore, been given, not in all cases but only where it was very necessary to do so. At some places only a gist of the quotations is given, and at places where even that is not given, it can be gathered from the context to a certain extent. In giving the meaning of Vedic *mantras*, the original text has been followed. Words that must be taken as understood for proper construction of the passage have been given in square brackets and equivalents of words or phrases in paranthesis*. Nothing has been added that is not in the original. The printing of Vedic *mantras* or Sanskrit verses is faultless on the whole. It was, however, impossible for me personally to write out the whole press copy. Consequently some errors might still have remained, if these were not noticed while correcting proofs ; but I could not help it.

Biographical sketches of astronomers have been given in the *Madhyamādhikāra* (Chapter on mean motions) ; these mainly deal with authors who compiled works on astronomy. If any of them happen to be compilers also of works on *Saṁhitā* and *Jātaka*, such works have been taken into account at the same place. As for the authors who have compiled no astronomical works but only works on *Saṁhitā* or *Jātaka*, their lives have been given in the sections devoted to these Skandhas (branches).

The life of each astronomer, as a rule, contains information on mostly the following points — his date, place, works compiled, commentaries on the works and an estimate of his capabilities. If any of his ancestors or descendants also happened to be authors, they are also taken into account. In addition to this, the remarkable feature of his life work, if any, has been mentioned in the contents. The contents give a list of works or their authors along with the Śaka year which indicates the year of compilation unless the words birth Śaka are added.

*This distinction could not be scrupulously observed in the English translation—*Translator.*

I am of opinion that the 'anusvāra' (a dot denoting the nasal sound) need not be added to the last letters of the words 'jethe', 'tethe', 'kothe' etc. and I also hold some independent views on the question of orthography. My views have been followed in certain cases; but the copyists, proof correctors and even the compositors have become so very familiar with the rule of the terminal dot, that the 'anusvāras' have found their way into this book, even though eliminated in the press copy.

It is my opinion that the names of ancient authors should not be mentioned in the honorific plural and this rule has been generally observed. As even the Almighty is spoken of in the singular, I do not think that the plural form e.g., "Bhāskarācārya Mhaṇatāt" implies any greater respect for the author. It can safely be said that there is no honorific plural either in Sanskrit or even in English. It is at present customary, however, to use the plural form while speaking of certain personages living or recently deceased. I have generally retained only this, lest a breach of the formality should jar on the ears of my readers.

As we are these days more familiar with the Christian era than the Śaka era, it is more convenient to discuss the dates of events in terms of Christian era. Our astronomical works, however, invariably use the Śaka era. Let the work belong to any part of India whatsoever, it is bound to use the Śaka year, even if it is not in use in every day life there. I have accordingly used the Śaka era almost everywhere in the book. However, the year indicated as B. S. (before Śaka) can safely pass for B. C., because the difference of 78 years is negligible where dates of very remote antiquity are concerned. Everywhere in this book the Śaka figure indicates the expired year unless it is specifically stated to be current. The planetary positions should be taken as *Nirayaṇa* or as calculated by the *Grahalāghava* system unless the word *Sāyana* is specifically used. Words like Sūrya-Siddhānta, Ārya-Siddhānta, and Brahma-Siddhānta used without qualification, should be taken to mean the current or later Sūrya-Siddhānta, the first Ārya-Siddhānta and the Brahmagupta-Siddhānta respectively.

It goes without saying that the index is very covenient for the purpose of reference. But experience alone can show how difficult it is to prepare an index. As it would have a long time to prepare it single handed, I have myself prepared only the subject index. In preparing the remaining indices I received considerable help from the present students of the Poona Training College. But as the work has passed through many hands and the lists were copied out five times before their final printing, some errors of omission and commission may have crept in at places; but no one could help it. It is the practice of our writers to include their works on Arithmetic and Algebra among those on astronomy and the practice has been adopted in preparing the index; similarly, the names of almanacs, Sanskrit and Marathi works and their authors have been included in the Sanskrit list. The letter Ṭī (denoting Ṭīp or footnote) has been left out at places before the page numbers in the index.

It would be difficult for the readers fully to realise what pains were taken to procure old works while writing this book, what people were coaxed and cajoled and in what way, how speedily the work of reading was done, and what mental and physical strain I had to undergo on the whole, while writing the present work and getting it printed. The pleasure of the pursuit was the only true reward of these labours.

The sale of the book is bound to be poor because it is scientific and of course I could not have shouldered the expensive and risky work of printing. But Mr. Hari Narayan Gokhale, a proprietor of the Aryabhushan Press, Poona, who is my former playmate and a fellow townman undertook the work and completed it with success. He has thus obliged me as well as the whole of Maharashtra. If he had not been pressing me to get the book printed and continued to press me to finish it soon while the printing was in progress, it would never have seen the light of the day, for it would never have really reached completion to my satisfaction till the end of my life. Had the whole manuscripts been ready at the outset, the publisher would have printed it within two months ; but the publica-cation was so long delayed, because my reading went on ceaselessly at the same time. The publication of a work of this kind must inevitably take a long time. Still, whatever work could be accomplished so far, has been brought to completion as far as possible. I shall feel much obliged if any defects found in this work are brought to my notice or suggestions made in regard to its contents.

I have received help from several people in several ways from the day I started writing till this day of publication. Even if I merely mention their names and the kind of help offered it would easily cover a page or two ; instead of doing this I wish to express my gratitude to all of them most sincerely even though in a general way.

It was a convention with the ancient writers on astronomy to give a brief account of themselves. I could write the major portion of the book because of this convention. Now I propose to follow suit and give a brief account of myself before I conclude the preface ; I was born on Tuesday, the 14th-cum-15th lunar day (tithi) of the bright half of Āsaḍha, Śaka 1775 (according to Grahalāghava Pañcāṅga) i.e. on 20/21 July 1853, at the village of Murud, in Dapoli Taluk, District Ratnagiri, my birth ascendant being Gemini. My ancestral line from father backwards runs thus ; Balakrishna, Ramachandra, Ballala and Shankar, and my mother's name was Durga. I am a Chitpavana Brahmana of Nityundan 'gotra', Hiraṇyakeśī branch. The original surname of our family was Vaiśampāyana. This family has inherited the priesthood and religious leadership of the village of Murud which was founded by a saint some centuries ago ; our original ancestor was his disciple and this vocation was conferred on him by the saint. About two years of my childhood were spent in elementary education at the village school and later in a local Government Marathi school, from April 1862 to October 1868. These very years were partly devoted to some study of Sanskrit and reciting of the *Vedas*. Part of the next two years passed in working as a candidate at Dapoli Court and a part in learning English. I was a student in the Poona Training College for three years from November 1870, when I obtained a first class certificate in the final examination of the third year. While studying at the Training College, I attended an English school one hour every day for two years. In 1874 I passed the Matriculation Examination, but I could not join College owing to several difficulties. I worked as the Head Master of the Marathi School at Revadanda from February 1874 to February 1880, and later on as Head Master of the Marathi School No. 1 at Thana up to August 1882. Afterwards I worked as an Assistant teacher at the English school at Barsi till the end of October 1889 and as an Assistant at the Dhulia Training School till the end of June 1894. Since then, I have been working as an Assistant Teacher at the Poona Training College. I wrote and published the following Marathi books in the years noted against them :

(i) Vidyārthī Buddhi Vardhinī (1876). (ii) Sṛṣṭa Camatkāra (1882). (iii) Jyotirvilāsa (1892). (iv) Dharma Mīmāṁsā (1895) and the Indian Calendar written in collaboration with Sewell has been recently published. I have also written a book entitled "Bhāratīya Prācīna Bhūvarṇana"; but since, it is not yet complete as it ought to be, it has not yet been published. That ours is not a family of *Jośis*, (astronomers or astrologers) is evident from the above account. My natural aptitude for learning and the habit of reading newspapers led me to take interest in the Sāyana controversy and eventually to the study of astronomy. Whatever knowledge of these subjects I possess, is wholly self acquired. Some people appear to think that I have some knowledge of astronomy that is not accessible to others; but my knowledge is so meagre that any intelligent man can acquire so much within six months if he has a fair knowledge of Marathi, Sanskrit and English, an aptitude for Mathematics and an inquiring mind. Many persons approached me with a request to teach them astronomy—it matters little that their enthusiasm was short lived. So vast are the treasures of astronomical knowledge, which, for various reasons, lie beyond the reach of my power of understanding, that my own knowledge is next to nothing in comparison. May Savitā (the Sun god) the self existant and stimulator of intelligence, inspire all of us to acquire knowledge.

SANKAR BALAKRISHNA DIKSHIT

Poona, Saturday the 31st October, 1896,
Sāyana Amānta Kārtika, Kṛṣṇa 10
Śaka 1818.

BHARATIYA JYOTISH SASTRA

A History of Indian Astronomy

—Ancient and Modern

INTRODUCTION

If on an autumn or winter night we sit in an open on a vast plain outside, we are naturally tempted to gaze at the heavens above. Thousands of tiny glowing stars would appear twinkling all around in the sky, some of them very small and some large. A closer look would then reveal that these shining articles are not stationary. Some of them would appear to be coming up from below, while some others going down on the other side. While we keep continually gazing at them some large bright star is suddenly noticed rising on the horizon ; and while we are looking at it in wonder, all of a sudden, some bright shining light at the lowest part of the sky appearing to touch the earth attracts our attention. The light gradually brightens in splendour and the stars on that side of the sky begin to fade out.

After a short while, the reddish disc of the moon is seen making its appearance which is indeed a most delightful sight of the night. As the moon slowly rises higher up in the sky, it spreads its most enchanting light on the earth, and a number of stars fade out one by one in the brilliancy of that light. While we are thus feasting our eyes, we may perhaps see a sudden flash of light and some star may appear to drop down from the sky. Sometimes we may be startled to see half a dozen such stars, small or lorge, dropping down from the heavens within a short interval of time.

The human mind is naturally attracted to such normal phenomena and the wonders of the sky being far more gorgeous and captivating than those of the earth, they attract one's attention to them all the more powerfully. People, who are somewhat indifferent to their worldly affairs for some reason or other, are more likely to be attracted by the wonders of the sky. Leave alone those who habitually and naturally take interest in such heavenly things, but a class of people may be found even among the common mass who can claim a fair knowledge of the stars, such as the cowherds who keep all night vigil in the open for protecting their cattle, or the peasants who get up early morning and attend to their work in open fields, or our sea-faring fishermen who seek guidance from the stars while navigating at night. Others too have a nodding acquaintance with the stars. In fact very few people would be found in our country who do not possess any elementary knowledge of the sky.

The sun and the moon rise and set regularly everyday. The seasons like summer, the monsoon, and other seasons also recur in their regular order. Today, however, we are not struck with wonder at these phenomena because of our familiarity with them ; but the primitive man at the beginning must have been overwhelmed with wonder at the regular recurrence of these phenomena, and his inclination must have been drawn to the study of the bright objects in the sky, that is to say, to the study of **astronomy** from the earliest times. The sun rises in the morning. It slowly comes up. After some time it reaches the highest point in the heavens, and then goes down slowly and the rays of the sun gradually lose intensity of heat till such time as

the sun vanishes. Then follows the darkness which continues for a long time. Next day, the sun rises again almost at the same point and not in any direction at random. The observer then wonders, "Is it yesterday's sun which has risen today or is there a new sun rising every day ? If it be the same sun where did it dwell at night ? Why does it not rise in any direction at random ? Why are its hot rays vary in intensity ? The sky appears to touch the horizon at the place where the sun rises; then how it is that the sun comes above out of that very place ? If there be an ocean in the east and an ocean in the west, the sun appears to be emerging from one and plunging into the other; does it really sink in the ocean ?" We do not attach any importance to such thoughts today ; but in the beginning human mind must have been haunted by these thoughts and much time must have elapsed before any of these problems could have been finally solved. The knowledge of human being grows by tradition and the experience of the past and this proves useful to the posterity. Even in modern times, year after year rolls by till we come across a new discovery, which might eventually seem to be trivial but at the time of ts invention it is taken as an established truth.

It is then obvious that at the beginning of civilization considerable time must have elapsed before the truth about even the most common place experiences came to be definitely known.

The questions above about the sun as having disturbed the primitive mind is not merely a figment of fancy. Evidence of such primitive thought is found in the Jain literature which shows that the **Jains** believed in the existence of two suns. The Purāṇas too have postulated twelve different suns for the twelve months of the year. The twelve *Ādityas* of the Vedic literature are also well known. Although these notions appear today to be fantastic, it is clear that there was a time when people really cherished such beliefs. For instance the following verse from the Rigveda would show that the sun was supposed to have actually sunk itself in ocean before rising the next day.

यद्देवा यतयो यथा भुवनान्यपिन्वत ।। अत्रा समुद्र आगूल्हमासूर्यमजभर्तन ।।

ऋ. सं. १०. ७२. ७.

"Oh gods ! you draw out the sun (for the purpose of rising up again in the morning) which was sunk in the ocean."

The following *mantra* from *Taittirīya Brāhmaṇa* may similarly be cited :

य उदगान्महतोर्णवाद्विभ्राजमानःसलिलस्य मध्यात् ।
समा वृषभो रोहिताक्षःसूर्यो विपश्चिन्मनसा पुनातु ।।

"May the resplendant sun, that comes up from the centre of the expanse of water of the vast ocean, purify me."

The sun rises in the morning. It reaches the highest point at noon and sets in the evening. As if it crosses the whole sky in three strides. This phenomenon has been described at various places in the Vedic literature. That the sun transfers its heat and puts it into *Agni* (fire) at night is also described a many places.

अग्निंवावादित्यः सायंप्रविशति ।। तस्मादग्निर्दूरान्नक्तं ददृशे ।।

तैत्ति. ब्राह्मण २ १ २. ८.

"The sun enters *Agni* in the evening. Hence *Agni* is visible at night even from a distance."

In this verse the sun is said to be entering *Agni* at night. The primitive man's attention must have been drawn to the moon just as much as to the sun or even more. Unlike the sun, the moon does not rise regularly at night. Sometimes when it rises at sunset the moon appears full in size, and then, a days pass on the moon rises later and later every day and gradually grows smaller in size. It also rapidly changes its position among the stars.

It slowly approaches the sun and a day comes when it becomes completely invisible and then after a day or two, the moon makes its appearanee in the west after sunset on the other side of the sun; but at that time, it appears only in the form of a crescent, as if it were newly born. It is well known that on this day even now we find that people joyfully offer her the frills of their garments and pray to her for new garments and long life, chanting all the while the following *Mantra* which is found in all the four Vedas.

नवो नवो भवति जायमानोह्नां केतुरुषसामेत्यग्रं ॥

भागं देवेभ्यो विदधात्यायन्प्रचंद्रमास्तिरते दीर्घमायु: ॥

ऋ. सं. १०. ८५. १९.

The moon gradually increases in size as days pass and again becomes full some day. Many descriptions of the moon's waxing and waning are found in ancient and modern works. And what is more, the digits of the moon, the dark spots on her face, her soft and serene appearance and her refreshing light, have provided an outstanding theme for poetic imagination in all countries at all times.

The moon becomes full after 29 or 30 days, and it becomes full again and again after the same number of days. The primitive man must have adopted the day (i.e. a day and night together) as the natural unit of time, after observing that the period between two successive sunrises is almost the same. Similarly, after observing the rule about the full moon stated above, he must have adopted the period between the consecutive full moons as the second but a longer unit of measuring time. This period seems to have received the same term as that given to the moon in many languages. In the Vedic literature, the moon is named as *māsa*. As an example the following lines may be seen :—

Ṛk Saṁhitā and Atharva Saṁhitā—

सूर्यामासामिथ उच्चरातः । ऋ. सं. १०. ६८. १०. अथ. सं. २०. १६. १०.

Ṛk Saṁhitā—

सूर्यमासा विचरंता दिवि । ऋ. सं. १०. ९२. १२.

That the name *māsa* originally given to the moon was later applied to the above mentioned period is well known.

After these two units, the day and the month, were firmly established, man must have observed that the rains, winter and summer recur after some definite period of time. It was also observed that the rains and other seasons recur after twelve months, where a 'month' denotes the period indicated by the full-moons. This (long) period of twelve months appears to have been called in the Vedas—*Śarad, Hemanta* etc. after the seasons in the Ṛk Saṁhitā. The term *Śarad* in the sense of a year, occurs there more than twenty times and the term *Hima* more than ten times. These words are found in many places in other parts of the Rigveda as well. The very word *Varṣa* meaning 'a year' also signifies a particular season.

शतंजीवशरदो वर्धमानः शतं हेमंतांछतमुवसंतान् ॥

ऋ. सं. १०. १६१. ४. अथ. सं. २०. ६६. ६.

"Do live and grow for a hundred autumns (i. e. years), for a hundred winters and for a hundred springs."—*Ṛk Saṁhitā and Atharva Śaṁhitā.*

The words *Śarad, Hemanta* and *Vasanta* all meaning a year occur together in the above verse. Even the term *Samvatsara* is very often found to have been used in the sense of a 'year.'

Any way the year is the third natural unit of time, but longer than the day and the month. So far we have had a glimpse of the origin of the three units of time. An attempt to describe in detail the gradual development of the basic astronomical concepts would involve a long exposition. This however is not necessary at this stage. The main features of this development are going to be described in detail later on.

Just as the observation of the sun and other heavenly bodies creates a sense of wonder, even so their regularity and other characteristics strike one as most surprising and inspire a feeling of reverence for them. It is but natural that one should be led to infer that these celestial phenomena are controlled by some eternal truth and that the magnitude of that truth is simply too great to be described. The following verses from Rigveda are worthy of note in this context :—

सत्येनोतभिता भूमिः सूर्येणोत्तभिता द्यौः ॥
ऋतेनादित्यास्तिष्ठंति दिवि सोमो अधिश्रितः ॥

ऋ. सं १०. ८५. १. अथ. सं. १४. १. १.

"The transcendental truth supports the universe, the sun is supporting the sky ; the twelve suns remain supported by truth and so remain the moon in the sky."—*Ṛk Saṁhitā and Atharva Saṁhitā.*

Even today we hear many people remark that all have discarded truth in this sinful *Kaliyuga*, but the sun and the moon have not.

Some celestial phenomena are joyful to watch, some are amazing while some others are even frightening. When the eclipses, shooting stars and

comets inspire a sense of awe and even fear in many a mind even in the present times, it is quite obvious that in the beginning these phenomena would have been regarded by the human being as extremely frightful and portentous of divine wrath. Many of us must have read how Christopher Columbus told the inhabitants of an island that because the god Sun was displeased with them he would hide himself on a particular day and how those people were frightened to see the prediction come true. Again it is a historical fact that the war, which had continued for five years between the people of Lydia and Media, about the year 584 B.C., came to an end by the mutual signing of a peace pact, because a total solar eclipse had occurred during the year and both the fighting parties were struck with horror to see the day suddenly turning into night.

It is also known to many of us that the Mahābhārata gives a description of how the two eclipses of the sun and the moon had occurred in the same month just before the terrific battle between the Kauravas and Pāṇḍavas was fought resulting in a tremendous loss of life. Similarly, in the Purāṇas we come across descriptions of shooting stars and meteors and appearances of comets preceding such calamities.

The natural units of reckoning time, i.e., the day, the month and the year which guide human activities, depend upon celestial phenomena. The knowledge about seasons which is necessary for agriculture depends upon the sun. That the rains are caused by the sun and the tides by the moon, and that it being felt that the wrath of Almighty is foreshadowed by some particular positions of the heavenly bodies, tend to show that curiosity must have aroused in human mind towards astronomical knowledge right from the creation of the human race. Again, certain ideas must have planted themselves in the human mind from very ancient times ; for instance, it might have been thought that since agriculture and other vocations of life are carried on when the sun and the moon occupy certain positions in the sky, it is quite possible that they would have been thought to prove beneficial when performed while the luminaries are in a typical position ; as for example, the fields may yield a bumper crop if the seed is sown when the moon is conjoined with a particular star and on the other hand crops are destroyed if sown when it is conjoined with another particular star ; some religious rites if performed when the sun turns from south to north or *vice versa* (that is on solstitial days) give beneficial or harmful results as the case may be. If marriages and such other rites are performed at certain auspicious moments they turn out to be beneficial ; when two planets were observed as passing very close to each other in the sky, they came to be interpreted as 'fighting with each other' and then one of them (the fainter of the two in luminosity) was regarded as having been defeated and this fight was supposed to be indicative of victory or defeat of a certain king on the earth ; it was also surmised as to what particular rites, if performed would nullify the malefic effects indicated by the appearance of eclipses, meteors or comets. Furthermore, it was but natural that ideas and convictions should have gradually begun to crop up in human mind that if the heavenly bodies have such a close association with the wordly affairs and their good or evil results, they must be affecting the individual life as well and then the people must have attempted to foretell what benefic or malefic effects would be experienced by any individual in his life, because the sun, the moon and the planets were occupying certain positions in the sky at the time of his birth and would be subsequently occupying other positions.

The quest of knowledge regarding such matters led to the creation of three branches. The following questions, for instance, are associated with Mathematics (Gaṇita): Finding out the number of days in a month, the number of months in a year and the number of days in a year; when will the winter solstice or the summer solstice occur after a particular day; what position in the sky will a particular planet be occupying on a certain day; when will an eclipse take place, and so on. These questions are related to Mathematics. The knowledge of the effects of eclipses, comets, planetary conflicts on the world and the knowledge as to what days are auspicious or otherwise for the performance of marriages and other rites—these questions form the second branch; and the third branch comprises the knowledge which enables one to judge the benefic or malefic effects that would be produced by a particular position of planets at birth or later on in the life of an individual. These are said to be the 'Three Branches' (*Triskandha*) of astronomy.

All the ancient and modern works in astronomy hold that the science is divided into these three branches. The first is called *Gaṇita*, the second *Saṁhitā*, and the third *Horā* or *Jātaka*. The *Gaṇita* branch is also known as *Siddhānta*.

Nārada observes:

सिद्धांतसंहिताहोरारूपं स्कंधत्रयात्मकं । वेदस्य निर्मलं चक्षुर्ज्योतिःशास्त्रमनूत्तमं ॥

नारदसंहिता. १. ४.

"The excellent science of astronomy comprising Siddhānta, Saṁhitā and Horā as its three branches (Sections) is the clear 'eye' of the Vedas". —*Nārada Saṁhitā 1. 4.*

Mahādeva (Śaka 1185), the commentator of Śripati's *Ratnamālā* says:—

ग्रहगणितपाटीगणितबीजगणितरूपसुनिश्चलमूलस्य बहुविधविततहोरातंत्रशाखस्य ज्योतिःशास्त्रवनस्पतेः संहितार्था एव फलानीत्यवधार्य, जातकर्मनामकरणमौजीबंधनविवाह-यात्रादौ निखिलसंहितार्थमल्पग्रंथेनाभिधातुमिच्छुः...आह ॥

"I am desirous of describing in brief, the interpretation of Saṁhitā rules which are necessary to be followed, while performing ceremonies relating to post-natal sacrament, naming the child, thread ceremony, marriage, travelling, etc., knowing fully well that Saṁhitās are 'fruits' of the tree of astronomy, of which the various forms of Horā are the 'branches' and elementary arithmetic, algebra and calculation of planetary places are the firm 'roots'."

Ganeśa Daivajña observes (about Śaka 1440) in his commentary on *Muhūrta Tattva* of Keśava.

श्रीकेशवो...गणितस्कंधं...जातकस्कंधं चोक्त्वा...संहितास्कंधं चिकीर्षुः...प्रतिजानीते

"Sri Keśava, having expounded......the Gaṇita branch and......Jātaka branch declares before proceeding to......the Saṁhitā branch."

The attention of our people was drawn to the study of celestial bodies from very ancient times ; still considerable time must necessarily elapse before any subject can evolve itself into a science. Similarly, a long time must have elapsed before the standard works on the subject of astronomy could be written, and it is obvious that the works which were written in the beginning of the evolution of the subject must have contained simple statements of facts of an elementary nature and those too of only broad outlines. The most ancient of the astronomical works extant in these days is the *Vedāṅga Jyotiṣa.* It deals with the mathematical aspect of only the sun and the moon ; the *Atharva Vedāṅga Jyotiṣa* may be a latter work*. This deals with some aspects of the second and the third branches of astronomy.

It seems as if the *Saṁhitās* of Garga and Parāśara belong to a later age. After the knowledge of astronomy had considerably developed it must have been grouped into three divisions or branches including *Gaṇita.* But this stage must have been preceded by certain works in which all the branches were discussed together. It appears that works of this type did exist and they too were known by the name *Saṁhitā.* Varāhamihira says in his *Bṛhat Saṁhitā* :—

ज्योतिःशास्त्रमनेकभेदविषयं स्कंधत्रयाधिष्ठितं ॥

तत्कात्स्न्योंपनयस्य नाम मुनिभिः संकीर्त्यते संहिता ॥ अध्याय १.

"The science of astronomy which comprises a variety of subjects is established mainly on three branches. But the treatment of the subject in its entirety is also named *Saṁhitā* by the sages."

We have no clue for ascertaining whether there were any works more ancient than the *Vedāṅga Jyotiṣa* and the *Saṁhitās* of Garga and others. None of these are available at present. Nor can we say with any degree of certainty whether the *Saṁhitās* of Garga and others that are available at present, have all retained their original composition and structure. In the case of *Garga Saṁhitā* some two or three versions are available. Nevertheless, it is evident that some *Saṁhitā* works containing a treatment of all the three branches together must have been in existence at one time, as is evident from the above quotation from Varāhamihira, let alone be the question whether such treatment was complete in itself or only fragmentary. As the knowledge of astronomy was progressing and as each branch was nearing perfection, different works, each devoted to some specific branch, came to be written and the term *Saṁhitā* was then exclusively applied to one branch in particular. Varāhamihira's *Pañcasiddhāntikā* shows that there were independent works on the different branches written before his time (i.e., before Śaka year 427). Āryabhaṭa's work, which deals exclusively with *Gaṇita*, belongs to a slightly earlier date than that of Varāhamihira. It will, however, be shown in detail, in the following pages, that the *Gaṇita* branch had become independent at a still earlier date. As for Varāhamihira himself, he has to his credit independent treatises on all the three branches.

Let us now enumerate the subjects commonly found in the works on each branch. The mathematical branch consists of three sections

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*Many subjects have been mentioned here only very briefly in order to give a general idea of later works ; their detailed survey will be made at appropriate places.

(i) *Siddhānta*, (ii) *Tantra* and (iii) *Karaṇa*. The Karaṇa works deal with planetary calculations only. Bhāskarācārya defines Siddhānta as follows :—

त्रुट्यादिप्रलयांतकालकलनामानप्रभेदः क्रमाच्चारश्च द्युसदां द्विधाच गणितं प्रश्नास्तथा सोत्तराः ।
भूधिष्ण्यग्रहसंस्थितेश्च कथनं यंत्रादि यत्रोच्यते सिद्धांतः स उदाहृतोऽत्र गणितस्कंधप्रबंधे बुधैः ॥६॥

सिद्धांतशिरोमणि, मध्यमाधिकार.

"The wise people describe the *Gaṇita Skandha* (i.e. the branch of mathematical astronomy) as that work, which gives in detail all the units of time from *Truṭi* (moment) to *Pralaya* (Universal deluge) and deals with the motions of planets, and which treats of mathematics in the form of questions and answers. It is mainly divided into two parts. It also describes the position of the earth, the stars, the planets and also the instruments for observation."—*Siddhānta Śiromaṇi, Madhyamādhikāra.*

Siddhānta or Tantra generally consists of two parts, one mainly deals with the calculation of planets' places and the other chiefly describes the structure of the universe ; and this includes the knowledge of the celestial sphere, the construction of instruments, the units of the measurement of time and other allied subjects. These two parts are not and cannot remain separate, Almost all Siddhāntas show as an intermingling of the two. Some people define Siddhānta, Tantra and Karaṇa in the following way :—

In the Siddhānta work the beginning of the *Kalpa* is taken to be the epoch ; in the Tantra the epoch is the beginning of a *Mahāyuga*, and in the Karaṇa any Śaka year can be the epoch, and the calculations of planets' places are made on the basis of the respective epochs. As a matter of fact there is no difference between them in regard to the computation of planetary positions excepting that each adopts a different epoch. The part of the work devoted to planetary calculations in all the three varieties contains a number of chapters called *Adhyāya* or *Adhikāra*. In general, the chapters are as follows :—

1. The mean places of planets.
2. The true places of planets.
3. The three problems (time, place and direction).
4. The lunar eclipse.
5. The solar eclipse.
6. The shadow cast by the gnomon.
7. The rising and setting of planets.
8. The elevation of the moon's cusp.
9. The conjunction of the planets.
10. The conjunction of planets and stars.
11. The luni-solar parallel.

It is not the fact that all works contain the same number of chapters as above. Although there are variations in the number and order of chapters, yet all of them have been included in the above list of eleven chapters.

There is no unanimity of opinion regarding the subject matter of the Saṁhitā branch. In general, the Saṁhitā may be regarded as divided into two parts. The first deals with the movement of planets in the Zodiac and their mutual conflicts, etc., the consideration of benefic or malefic effects of meteors, comets, eclipses and omens on the world. The second is devoted to the selection or consideration of auspicious moments or otherwise, for starting on a journey, the celebration of a marriage etc. Varāhamihira's works show that in his time both the branches enjoyed equal importance, but from Śrīpati's time, that is from Śaka 960, the first part began to lose its importance and from about Śaka 1450, the second part gained so much importance that only the chapter on *muhūrta* began to pass for the third branch. This can be confirmed from the titles and the subject matter of the following works :—Muhūrta Tattva, Muhūrta Mārtaṇḍa, Muhūrta Cintāmaṇi, Muhūrta Cuḍāmaṇi, Muhūrta Dīpaka, Muhūrta Gaṇapati and others. The works on Muhūrta do contain some of the subjects described by Varāhamihira in his *Bṛhat Saṁhitā* but not with any degree of importance.

The *Horā* branch originally represented the study of the ascendant of birth in one's horoscope, and the prediction of all the happy and sorrowful events of life ; but afterwards it was divided into two parts, the above mentioned part being one of them. In the beginning, the complete Horā section was known as *Jātaka*, but later on this particular part relating to the ascendant came to be known as *Jātaka* and the second part as *Tājik*. The principal subject of *Tājik* generally is the study of events, good or evil, in any individual life, from the ascendant of the annual horoscope which is cast for the moment of his entry into any new year of his age reckoned on solar basis. Under this system of horoscope reading, the radical ascendant is regarded as a planet and is known by the name *Muthahā* (Munthā?). Some authors have coined the Sanskrit term *Tārtīyaka* for *Tājik*. This part of *Horā*, viz., *Tājik* came into vogue from about Śaka 1200, that is by about the time of increasing Muslim domination in our country.

In the books on astronomy in this country, the chapter which generally deals with such problems as positions of the sun, the moon, the earth, etc. in the universe, the causes of their motions and the nature of such motion is known as *Bhuvana Saṁsthā*, *Jagat Saṁsthā*, *Bhuvana Kośa* or by some other equivalent names. These three subjects will be discussed in detail later on at the proper place ; but to introduce the subject, the celestial sphere, the motions of planets, the movement of the solstitial points, and the *Yuga* system of measuring time are briefly described below.

BHUVANA SAṀSTHĀ (The Celestial Sphere)

According to our astronomical works the earth is at the centre of the Universe; the moon and other bodies revolve around it; their order is, the Moon, Mercury, Venus, the Sun, Mars, Jupiter, Saturn, and the starry belt ; the Zodiac revolves round the axis joining the two fixed poles. The earth is round, it stands supportless and is enveloped by air which is called *bhūvāyu* or earthly-air, Above this is the sky, where blows the wind called *pravaha* by the force of which the moon and other heavenly bodies are kept in

motion, and they revolve round the earth. This description is found in all *Siddhānta* works and *Tantras*, but not in *Karaṇa*-works. It is also found in the *Pañca-Siddhāntikā*. In no man-made or written works on astronomy do we find any expression of views more ancient than those found in the *Pancā-Siddhāntikā* and hence the lines presenting the above ideas are quoted below :

पंचमहाभूतमयस्तारागणपंजरे महीगोल: ॥

खेऽयस्कांतांत:स्थो लोह इवावस्थितो वृत्त: ॥१॥

मेरो: समोपरि वियत्यक्षो व्योम्नि स्थितो ध्रुवोऽधोन्य: ॥

तत्र निबद्धो मरुता प्रवहेण भ्राम्यते भगण: ॥५॥

चंद्रादूर्ध्वं बुधसितरविकुजजीवार्कजास्ततो भानि ॥३९॥

अध्याय १३ त्रैलोक्यसंस्थान.

"The round ball of the earth, composed of the five elements, abides in space in the midst of the starry sphere, like a piece of iron suspended between magnets. 1. Straight above *merū* in space one pole is seen; the other pole is seen below, placed in space. Fastened to the poles the sphere of the stars is driven round by the *pravaha* wind. 5. Above the moon there are Mercury, Venus, the Sun, Mars, Jupiter, and Saturn, and then the stars. 39." —*Trailokya Saṁsthāna, Chapter 13.*

The starry belt, along with planets, appears to make one complete revolution round the earth in about one day. But it was only Āryabhaṭa I, who held the modern view that this diurnal motion is not real but apparent and is caused by the diurnal rotation of the earth; others held that the diurnal motion of the starry belt was real and almost all the authors of Siddhāntas have blamed Āryabhaṭa for holding a divergent view.

The planets appear to move from west to east with respect to the stars and in the science of astronomy this kind of planetary motions have principally to be dealt with. The Sūrya-Siddhānta has explained this eastward motion of planets as follows :—

पश्चाद् व्रजंतोऽतिजवान्नक्षत्रै: सततं ग्रहा: ॥ जीयमानास्तु लंबंते तुल्यमेव स्वमार्गगा: ॥२५॥

मध्यमाधिकार.

"The planets being overtaken by the stars moving with greater speed in their westward motion, fall behind equal distances in their orbits (and hence they get an eastward motion)"—*Madhyamādhikāra-25.*

In substance, this means that the diurnal motions of planets being less than those of the stars, the planets lag behind and hence they appear to move eastward with respect to the stars.

Āryabhaṭa I had already taken it for granted that the diurnal motion of the stars was not real and hence it was not necessary for him to make any assumption like the above to explain the eastward motion of the planets. He had already assumed a real eastward motion for them.

Another kind of assumption which has been made about the motion of planets is that their eastward motions in their orbits are equal. But the distances of planets from the earth being unequal, the orbits of farther planets are wider than those of the nearer ones; and that is the reason why we notice difference in their eastward motions. The moon being nearest to the earth has the swiftest motion and Saturn being the farthest of all planets, its motion is the slowest. The *Pañca-Siddhāntikā* says :—

प्रागगतयस्तुल्यजवा ग्रहास्तु सर्वे स्वमंडलगाः ॥३९॥
पर्येति शशी शीघ्रं स्वल्पं नक्षत्रमंडलमधस्थः ॥
ऊर्ध्वस्थस्तुल्यजवो विचरति महदर्कजो मंदं ॥४१॥
अ० १३ त्रैलोक्यसंस्थान.

"All planets move towards the east with the same velocity each in its own orbit. 39. The moon which is placed (lowest) below the sphere of the stars revolves quickly in its small orbit; Saturn which is placed highest above revolves slowly in its large orbit with the same velocity."—*Trailokya Saṁsthāna, Chap. 13.*

One complete revolution of a planet in the zodiac is called *bhagaṇa*. It is obvious that the time for one *bhagaṇa* must have been determined after observing the times taken by the planet in making several revolutions. The astro-mathematical works give the number of *bhagaṇas* which each planet completes in the period of one *Kalpa* or one *Mahāyuga*. The motion of a planet as calculated from these periods using the *bhagaṇas* mentioned by the Pañca-Siddhāntikā must be the same for every day. This is called the 'mean motion'. But the motion of a planet as actually seen in the sky is not always the same. For instance, Jupiter takes about twelve years for one revolution and hence its mean daily motion comes to be about 5′; but the actual observation of the planet shows that Jupiter sometimes moves faster than that and sometimes slower; its daily motion is sometimes found to be as much as 15′ and sometimes it is slower than even 1′; not only this but sometimes the planet also appears even to move in a reverse direction *i. e.* from east to west (this is called retrograde motion). The planet's daily motion as is actually seen is termed 'true or apparent' motion; similary the planet is actualy found to be somewhat ahead of or behind the position calculated from its mean motion. The real position of a planet is called its 'true place' and that found by adopting the mean motion is called its 'mean place'.

To find the true place of a planet at a given moment, which in other words is to find where the planet will be observable in the sky at a particular time, is the main subject of the mathematical branch of astronomy.

THE AYANA CALANA

(The shifting of the solstitial points)

The period that elapses between two successive 'conjunctions' of the sun with a particular star is termed *Nākṣatra saura varṣa* or 'Sidereal Solar year'. The two points of intersection of the ecliptic and the equator are called *Sampāta* or *Krāntipāta* (*i.e.* equinoxes). The equinox from which the sun enters into the northern side of the equator and which marks the spring season is known as *Meṣa* or *Vasanta Sampāta*, that is, the vernal equinox.

Let us suppose that at some time there is a star coinciding with this equinoctial point and that when the sun comes to that point the year commences. The equinox has got a motion, and it recedes back at the rate of 50″ per year. On account of this, the stellar zodiac appears to be moving to the east by an equal arc. The time taken by the sun to return to the same equinox is termed as *Sāṁpātik Saura* (*i.e.*, tropical) year. This is also called the *ārtava* (seasonal), and the *sāyana* year. When the sun would return to the same equinox it would, as it were, find the above-mentioned fixed star still 50″ ahead, and it would require about 50 *palas* (twenty minutes) more to arrive at the star. Hence, the sidereal year is found to be longer than the tropical year by about 50 *palas*. The seasons depend upon the tropical year. If there is a particular season when the sun comes to an equinox, the same season would recur every time the sun returns to the same equinox again; on the other hand, it is evident that the same season would not be found recurring at every conjunction of the sun with a star. If one point of the orbit shifts its position every other point also does so. As the equinoctial point recedes, the solstitial points also fall back; hence if the winter solstice is found to occur when the sun is near a particular star, the future solstitial transits will be found occurring gradually further westward from that star. The motion of the solstitial points which is the same as that of the equinoctial points was first detected from the westward position of the sun with respect to stars at the time of successive solstices. Hence, this motion is termed as *Ayana Calana* or the shifting of the solstitial points.

THE YUGA SYSTEM OF MEASURING TIME

The measure (length) of the *Kaliyuga* is 4,32,000 years. Those of *Dvāpara*, *Tretā* and *Kṛta* are respectively twice, thrice and four times of this. These four *yugas* constitute the *Mahāyuga* and its measure is ten times that of the *Kaliyuga* and is equal to 43,20,000 years. One thousand such *Mahāyugas* make one *Kalpa*, which is known as *Brahmā's* day. The *Kalpa* contains 14 *Manus*. So far, a period equal to 6 *Manus* and 27 *Mahāyugas* has elapsed from the commencement of the *Kalpa* up to the present *i.e.* the 28th *Mahāyuga*; and after passing through *Kṛta*, *Tretā* and *Dvāpara* of the current *Mahāyuga*, we are now passing through the *Kaliyuga*.

71 *Mahāyugas* make one *Manu* and a period equivalent to a *Kṛtayuga* known as 'Manu-sandhi' (*i.e.*, the transition period between two *Manus*), is reckoned in the beginning of each Manu period. This means that a period equal to 4567 *Kaliyugas* have elasped from the commencement of *Brahmā's* day up to the present *Kaliyuga*. All *Siddhāntas* with the exception of that of Āryabhaṭa agree on these points, although they hold somewhat different views on other matters.

According to the modern *Sūrya-Siddhānta* and Āryabhaṭa I, all the seven planets including the sun and the moon were together in the beginning of the present *Kaliyuga*. In other words, the mean longitude of each of these bodies was zero ; but according to Brahmagupta and Āryabhaṭa II, all the planets had such a general conjunction only at the commencement of the *Kalpa*, and not at that of the present *Kaliyuga* when they were situated within a range of 3 to 4 degrees from one another. There is yet another divergent view which will be explained later on.

This book relates the history of the study of the positions and motions of heavenly bodies and that of the development of the various aspects of astronomical knowledge in our country. The ancient name of our country is Bhārata Varṣa, Bhārata Khaṇḍa, or Bhārata. Because this book contains the history of astronomical science in our country, it is titled "*Bhāratīya Jyotiṣa Śāstra*—(its) *Ancient and Modern History*".

Saṁhitā and *Jātaka*, the two branches of astronomy, depend upon the motions of planets and stars. The chief aim of our astronomy is the prediction of actual planetary positions, that is foretelling what place in the sky a particular planet would be occupying at a particular time. Its complicatedness is inherent. An accurate knowledge of the mean motions and positions of planets emanates from an accurate knowledge of their true positions and motions. Even before they acquired the capacity to predict accurately their apparent positions, the ancients did possess a tolerably accurate knowledge of planets' mean motions and positions. This was the preliminary stage. The *Siddhāntas* and other available astronomical works deal with the calculations of true positions and motions of planets. A considerable period of time must, however, have elapsed before man's knowledge of astronomy reached that stage.

The history of astronomy has, therefore, been divided into two major divisions, *viz.*, (i) the Siddhāntic period and (ii) the pre-Siddhāntic period, and accordingly this book has been divided into two parts. 'Part One' gives the history of how the people in pre-Siddhāntic age had taken increasing interest in astronomy, how the relevant knowledge had grown, and how it reached the stage of foretelling the true places of planets, this history being traced from the casual astronomical references found in the Vedas, Vedāṅgas Smṛtis and the Mahābhārata, and the subsequent history up to the present time is given in 'Part Two'. The pre-Siddhāntic period and consequently Part One, has again been sub-divided into two sections : (i) the Vedic period and (ii) the Vedāṅga period. The first section deals with the history of astronomy collected from references found in the Vedic Saṁhitās, Brāhmaṇic works and some Upaniṣads. The second section deals with the history of astronomy gleaned from the Vedāṅgas, the Smṛti works and the Mahābhārata. The

Vedāñgas contain two works whose whole subject matter is astronomy. These, however, deal with the mean motions and positions of planets and they are more ancient than the Siddhānta works, and that is why their study is given a place in Part One. A discussion of the limits of the periods to be assigned to the Vedic, the Vedāñga and the Jyotiṣa-Siddhānta ages is given at the end of the part. 'Part Two' is devoted to the history of the three branches of astronomy.

The history of mathematical astronomy in this part has been presented in the order of *adhikāra* or chapters, as already mentioned, *viz.*, the mean motions, true motions, etc. A description of the celestial sphere, the system of observation, the precession of solstices, etc., have been given in the same part. In the treatment of these subjects references to several works and authors are required to be quoted, and without their knowledge some difficulty is likely to be experienced in rightly appreciating the discussion. Hence a detailed history of astronomical works and their authors is given in the chapter on the mean motions of planets in the beginning of 'Part Two' and a discussion of the mean places and motions of planets will be found in the same chapter. The chapter on the 'true motions' is devoted to the study of true positions, motions of planets and a detailed description of the five parts of the *Pañcāṅga* (almanac) and that of different *Pañcāṅgas* current in different provinces of our country.

An adequate idea regarding the subjects and the order in which they are dealt with in the two parts may be obtained from the table of contents.

PART—I

HISTORY OF ASTRONOMY DURING

THE VEDIC & THE VEDANGA PERIODS

Section I

The Vedic Period

Let us consider what subjects relating to astronomy are found in the Vedas and in what manner they have been treated. It need not be explained that the Vedas are not essentially a literature solely devoted to astronomy, and it is, therefore, obvious that no astronomical information would have deliberately been presented through them. Hence, all that one can do is to draw certain general inferences from the astronomical ideas occurring incidentally among other things, and where such inferences cannot be drawn in the absence of sufficient material of a consistent nature, to make a bare statement of stray ideas that may have been elicited.

Even a cursory glance at the Vedas will at once show that our ancient ancestors had a great liking for the observation of natural phenomena, particularly the wonders of the sky. If one looks into any of the Vedas or even any part or any chapter thereof, it would not generally happen that one does not come across some passages describing the sky, the moon and the sun, the dawn and the sun beams, the stars and asterisms, the seasons and months, the day and night or the wind and clouds. The description itself is enchanting, life-like, beautiful, amazing and awe-inspiring. The author refrains from giving specimens of such descriptions for that would be a digression needlessly leading us far afield.

ORIGIN OF THE UNIVERSE

Let us now see what description do we find in the Vedas about the "creation of the world" and the "structure of the universe".

देवानां नु वयं जाना प्रवोचाम विपन्यया ॥ उक्थेषु शस्यमानेषु यः पश्यादुत्तरे युगे ॥१॥
ब्रह्मणस्पतिरेतासं कर्मार इवाधमत् ॥ देवानां पूर्व्ये युगेसतः सदजायत ॥२॥
देवानां युगे प्रथमेसतः सदजायत ॥ तदाशा अन्वजायंत तदुत्तानपदस्परि ॥३॥
भुर्जज्ञ उत्तानपदो भुव आशा अजायंत ॥ अदितेर्दक्षो अजायत दक्षाद्वदितिः परि ॥४॥
अदितिर्ह्यं जनिष्ट दक्षया दुहिता तव ॥ तां देवा अन्वजायंत भद्रा अमृतबंधवः ॥५॥

ऋ. सं. १०. ७२.

"(1 and 2) We describe the births of gods in plain words—the (assembly of) gods which even though born in a former *yuga* sees the reciter (*stotā*) in the latter part of the *yuga*, while *śāstras* were sung (in sacrifices) like the *Karmār Brahmaṇaspati* created the gods. The *sat* (real) was created from *asat* (non-existent) in the first half of the divine *yuga*.

(3) The *sat* was created from *asat* in the first divine yuga; then the directions came into existence and then the *uttāna-pada* followed.

(4) The *uttāna-pada* gave birth to the earth, which in its turn gave birth to diretions. *Dakṣa* was born of *Aditi*. *Aditi* was born from *Dakṣa*.

(5) Oh *Dakṣa* ! The praiseworthy and immortal gods were born after your daughter *Aditi.*" *Ṛk Saṁhitā,* X, 72.

This means, in a general way, that some kind of Being or Existence arose first, then came into existence the directions and then the earth.

The following lines from the *Ṛk Saṁhitā* may be seen :—

ऋतंच सत्यं चाभीद्धात्तपसोऽध्यजायत ।। ततो रात्र्यजायत ततः समुद्रो अर्णवः ।।१।।
समुद्रादर्णवादधिसंवत्सरो अजायत ।। अहोरात्राणि विदधद्विश्वस्य मिषतो वशी ।।२।।
सूर्याचंद्रमसौ धाता यथापूर्वमकल्पयत् ।। दिवं च पृथिवीं चांतरिक्षमथो स्वः ।।३।।

ऋ. सं. १०. १९०.

"(1) Truth (of thought) and truthfulness (of speech) were born of ardour penance, thence was night generated, thence also the watery ocean.

(2) From the watery ocean was the year afterwards produced,' ordaining nights and days, the ruler of every moment.

(3) Dhatri in the beginning created the sun and the moon, the heaven, the earth, the firmament and the happy (sky)".

These mantras occur in other Vedas also. The following description is given in a passage in *Taittirīya Brāhmaṇa* :—

आपो वा इदमग्रे सलिलमासीत् ।। तेन प्रजापतिरश्राम्यत् ।। कथमिदँस्यादिति ।।
सो पश्यत्पुष्करपर्णं तिष्टत् ।। सोमन्यत ।। अस्ति वै तत् ।। यस्मिन्निदमधितिष्ठतीति ।।
स वराहोरुपं कृत्वोपन्यमज्जत् ।। स पृथिवीमध आर्छत् ।। तस्या उपहत्योदमज्जेत् ।।
तत्पुष्करपर्णेऽप्रथयत् ।। यदप्रथयत् ।। तत्पृथिव्यै पृथिवित्वं ।।

अष्टक १ अध्याय १ अनुवाक ३.

The quotation describes that there was water in the beginning and that the earth was created thereafter. The Taittirīya Saṁhitā also gives similar account of the 'creation' in the following lines;—

आपो वा इदमग्रेसलिलमासीत् तस्मिन् प्रजापतिर्वायुर्भूत्वा चरत्स इमामपश्यत्तां वराहो भूत्वाऽ-
हरत्तां विश्वकर्मा भूत्वा व्यमार्ट् सा प्रथत सा पृथिव्यभवत् तत्पृथिव्यै पृथिवित्वं ।।

अष्टक ७ अध्याय १ अनुवाक ५.

According to this, water, air, and the earth, is the order of creation. The following passage from one of the Upaniṣads shows a more systematic treatment of the subject of creation.

तस्माद्वा एतस्मादात्मन आकाशः संभूतः ।। आकाशाद्वायुः ।। वायोरग्निः ।। अग्नेरापः ।।
अद्भ्य पृथिवी ।। पृथिव्या ओषधयः ओषधीभ्योन्नं अन्नात् पुरुषः ।।

तैत्तिरीयोपनिषद २. १ (ब्रह्मवल्ली प्रथम खंड)

"From this Soul (*Ātman*), verily, space (*ākāśa*) arose ; from space, wind (*vāyu*) ; from wind, fire ; from fire, water ; from water, the earth ; from the earth, herbs ; from herbs, food ; from food, semen ; from semen, the person (*puruṣa*)."—*Taittirīya Upaniṣad; 2.1 Brahma Valli.*

A description of the creation of the universe is found in several places. We come across a curious statement made by Taittirīya Brāhmaṇa that although the Vedas do describe the creation of the world and the order, no one can state the actual cause of creation, for no one knows it.

नासदासीन्नोसदासीत्तदानीं ॥ नासीद्रजो नो व्योमापरायेत् ॥ किमावरीवः कुह कस्य शर्मन् ॥ अंभः किमासीद्गहनं गभीरं ॥ न मृत्युरमृतं तर्हि न ॥ रात्रिया अन्ह आसीत्प्रकेतः ॥ आनीदवातं स्वधया तदेकं ॥ तस्माद्धान्यं न परः किंच नास ॥ तम आसीत्तमसा गूढमग्रे प्रकेतं ॥ सलिलं सर्व मा इदं ॥ तुच्छेनाभ्वपिहितं यदासीत् ॥ तमसस्तन्महिमा जायतैकं ॥ कामस्तदग्रे समवर्ततार्धि ॥ मनसो रेतः प्रथमं यदासीत् ॥ सतो बंधुमसति ॥ निरविंदन् ॥ हृदि प्रतीष्या कवयो मनीषा ॥ तिरश्चीनो विततो रश्मिरेषां ॥ अधस्विदासी३दुपरिस्वदासी३त् ॥ रेतोधा आसन् महिमान आसन् ॥ स्वधा अवस्तात्प्रयतिः परस्तात् ॥

तै. ब्रा. २. ८. ६.

It says that after the deluge submerged the first universe, and prior to the creation of the next one, there existed neither the 'Real' nor the 'Unreal'. There was neither sky nor water, neither death nor immortality, neither the sun nor the moon to illuminate the day and the night. There was only one all-pervading Brahma. It then desired to create and the Universe was created and so on. It then goes on to say :—

को अद्धा वेद क इह प्रवोचत् ॥ कुत आजाता कुत इयं विसृष्टिः ॥ अर्वाग्देवा अस्य विसर्जनाय ॥ अथो को वेद यत आबभूव ॥ इयं विसृष्टिर्यत आबभूव ॥ यदिवादधे यदिवा न ॥ यो अस्याध्यक्षः परमे व्योमन् ॥ सो अंग वेद यदि वा न वेद ॥ किं* स्विद्वनं कउस वृक्ष आसीत् ॥ यतो द्यावापृथिवी निष्टतक्षुः ॥

तै. ब्रा. २. ८. ६.

"Who really knows whence and how this Universe was created? Or who can tell it? Even the gods were born later; who knows Him from whom the world was created? Who knows the 'tree' from which the heaven and the earth were created and in what 'forest' was it growing? It is only He, the controller of all these things, who dwells in the 'Supreme ether', who knows this. Perhaps no one knows if even He knows this or not."

It is clear that the above passage implies that because no one knows the cause of creation of the Universe, no one definitely knows the order in which creation took place.

At one place in the Rigveda a sage remarks as follows :—

तिस्रो द्यावः सवितुर्द्वा उपस्थां एका यमस्य भुवने विराषाट् ॥ आणिं न रथ्यममृताधि तस्थुः

ऋ. सं. १. ३५. ६.

"There are three heavens. Two of them lie within the Sun and one of them in the abode of Yama .... (The moon, the

*The mantra 'Kim swidvanam' occurs in Vājasaneyī Saṁhitā (17-20). Similar all mantras preceeding it occur in Ṛk Saṁhitā (10-129). The 'Kim Swidvanam' mantra occurs in (10-31).

tars and) other gods dwell there. If there be one who has known this, let him come here and relate it to us."

The object of the sage is to state that there can be no one who actually knows this.

Even then it seems that even in the Vedic age, people had a fair knowledge of the structure of the world and at least that of the configuration of the earth.

CONFIGURATION OF THE UNIVERSE

In many places, where a reference is to be made to the world, terms like *Rodasī*, *Dyāvāpṛthivī* or their equivalents, denoting a combination of the heaven and the earth have been used, which in turn shows that the world was supposed to be divided into heaven and earth as its two parts. In some places the heavens are described as being three in number. Three heavens have been indicated at several places in the Rigveda. In some places the heaven is described as the highest part of the sky or the surface of the sky. But in many other places the Universe is supposed to be divided into *Dyu* (sky), *Antarikṣa* (space) and *Pṛthivī* (earth) as the three parts ; of these, the *antarīkṣa* lies in an intermediate position between the heaven and the earth and is the abode of the winds, clouds and lightning and the birds fly in it. These three parts are described in clear words in the following well-known lines of the *Puruṣa-Sukta* :—

नाभ्या आसीदंतरिक्षं शीर्ष्णो द्यौः समवर्तत ॥ पद्भ्यां भूमिः

and corresponding to their high and low positions they are believed to have been created respectively from the head, the navel, and the feet of the 'Supreme Being'.

The following verses may further be noted :—

यः पृथिवीं व्यथमानमदंहद्यः पर्वतान् प्रकुपितां अरम्णात् ॥
यो अंतरिक्षं विममे वरीयो यो द्यामस्तभ्नात्स जनास इंद्रः ॥

ऋ. सं. २. १२. १.

"Oh people ! He is the same god Indra who kept the shaking earth in firm position..............who adjusted the expansive space and who supported the heaven."

त्रिर्नो अश्विना दिव्यानि भेषजा त्रिः पार्थिवानि त्रिरुदत्तमद्भ्यः ॥

ऋ. सं. १. ३४. ६.

"Oh Aśvins ! May you give us heavenly medicines thrice from heavens, thrice from the earth and thrice from space."

The interpretation of the word *Adbhyaḥ* in the original text is "from the place where water-laden clouds dwell", meaning the sky (*antarikṣa*) ; many proofs could be given in support of this interpretation and therefore it is clear that the word *antarikṣa* stands for that space in which water-laden clouds, move.

येमहीं रजसो बिदुर्विश्वेदेवासो अद्रुहः । मरुद्भिरग्न आगहि ॥

ऋ. सं. १. १६. ३.

"Oh *Agni* (fire), please come here along with all those ***Maruts*** **(gods)** wh dwell in the expansive space".

These lines show that the space is the abode of 'Maruts' i.e. wind.

बेदा यो वीनांपदमंतरिक्षेण पततां ॥ ऋ. सं. १. २५. ७.

neaning "(*Varuṇa*) who knows the path of the birds flying through the space" shows that '*antarikṣa*' is the space in which the birds fly.

It is clear from the following lines from *Aitareya Brāhmaṇa* (11-6) tha '*antarikṣa*' is that space which lies between the heavens and the earth.

द्यौरंतरिक्षे प्रतिष्ठितांतरिक्षं पृथिव्यां ॥ ऐ. ब्रा. ११. ६.

That the sun is moving through the highest region of the heavens is describe in many places. The following lines may be seen for this :—

उद्यन्नद्य मित्रमह आरोहन्नुत्तरां दिवं ॥ हृद्रोगं मम सूर्य हरिमाणं च नाशय ॥

ऋ. सं. १. ५०. ११.

"Oh Sun-god with agreeable lustre ! Cure the disease of my heart afte ascending the highest point in the heavens."—*Ṛk Saṁhitā*.

The idea that the sun shines at a very great distance from the earth can be seen from some of the following lines :—

यथाग्निः पृथिव्या समनमदेवं मह्यं भद्राः सन्नतयः सन्नमंतु वायवे समनमदंतरिक्षाय समनमद् यथा वायुरंतरिक्षेण सूर्याय समनमद् दिवे समनमद् यथा सूर्यो दिवा चंद्रमसे समनमन्नक्षत्रेभ्यः समनमद् यथा चंद्रमा नक्षत्रैर्वरुणाय समनमत् ॥ तै. सं. ७. ५. २३.

"Agni (fire) had to stand in a lower position before wind and space on account of the earth. The wind stooped low before the Sun and the sky on account of space. Similarly, the sun had to stand low in position on account of the moon and the stars ; and the moon had to 'bend low' before *Varuṇa* (god of rains) on account of stars"—*Taittirīya Saṁhitā.*

The description appears to imply that the fire rests on earth, the wind takes shelter in space, the sun traverses the sky and the moon moves through the zodiac. It appears from this that the moon was supposed to occupy a higher position than that of the sun.

लोकोसि स्वर्गोसि ॥ अनंतोस्यपारोसि ॥ अक्षितोस्यक्षय्योसि ॥ तपसः प्रतिष्ठा ॥ *त्वयीदमंतः ॥ विश्वं यक्षं विश्वं भूतं विश्वं सुभूतं ॥ विश्वस्य भर्ता विश्वस्य जनयिता ॥ तंत्वोपदधे कामदुघमक्षितं ॥ प्रजापतिस्त्वासादयतु ॥ तया देवतयांगिरस्वध्रुवासीद ॥ तपोसि लोके श्रितं ॥ तेजसः प्रतिष्ठा ॥ त्वयीद...॥ तेजोसि तपसि श्रितं ॥ समुद्रस्य प्रतिष्ठा... ॥ समुद्रोसि तेजसि श्रितः ॥ अपां प्रतिष्ठा ॥...॥ आपः स्थ समुद्रे श्रिताः ॥ पृथिव्याः प्रतिष्ठा युष्मासु ॥...॥ पृथिव्यस्यप्सुश्रिता ॥ अग्नेः प्रतिष्ठा ॥ ... ॥ अग्निरसि पृथिव्यां श्रितः ॥ अंतरिक्षस्य प्रतिष्ठा ॥ ... ॥

* Six sentences following this, have been given with the necessary change in the gender and number of each of the words *Teja* and *Samudra* (Sea) etc., in the original. They have not been repeated here.

अंतरिक्षमस्यग्नौ श्रितं ॥ वायोः प्रतिष्ठा ॥...॥ वायुरस्यंतरिक्षे श्रित : ॥ दिवः प्रतिष्ठा ॥...॥ द्यौरसि वायौ श्रिता ॥ आदित्यस्य प्रतिष्ठा ॥...॥ आदित्योसि दिवि श्रितः ॥ चंद्रमसः प्रतिष्ठा ॥...॥ चंद्रमा अस्यादित्ये श्रितः ॥ नक्षत्राणां प्रतिष्ठा ॥...॥ नक्षत्राणि स्थ चंद्रमसि श्रितानि ॥ संवत्सरस्य प्रतिष्ठा युष्मासु ॥...॥ †संवत्सरोसि नक्षत्रेषु श्रितः ॥ ऋतूनां प्रतिष्ठा ॥...॥ ऋतवः स्थ संवत्सरे श्रिता : ॥ मासानां प्रतिष्ठा युष्मासु ॥...॥
मासाः स्थर्तुषु श्रिताः ॥ अर्धमासानां प्रतिष्ठा युष्मासु ॥ ... ॥ अर्धमासाः स्थ मासु श्रिताः ॥ अहोरात्रयोः प्रतिष्ठा युष्मासु ॥ ... ॥ अहोरात्रे स्थोर्धमासेषु श्रिते ॥ भूतस्य प्रतिष्ठे भव्यस्य प्रतिष्ठे ॥ पौर्णमास्यष्टकामावास्या ॥ अन्नादा स्थानदुघो युष्मासु ॥ राडसि बृहती श्रीरसीं द्रपत्नी-धर्मपत्नी ॥ ओजोसि सहोसि बलमसि भ्राजोसि ॥ देवानां धामामृतं ॥ अमर्त्यस्तपोजाः ॥ ... ॥

तै. ब्रा. ३. ११. १.

The word *loka* occurring in the first three lines of the above passage refers to the Universe. It praises Him with the words "Thou art the world, thou the heaven ; thou art Unending, Infinite, Eternal and Indestructible." It is needless to point out that the sequence occurring in these sentences does not necessarily imply a high-and-low lineage of created objects. In some places, the relation indicated is cause and effect ; in some, the container and the contained, and in some others, the part and the whole. It, however, embodies in it the sequence mentioned here before wherein, the heavens are above the space, and space above the earth, and also the idea that the sun is supported by the sky.

THE EARTH, SPACE AND THE HEAVENS

The above discussion in short shows that the earth, space and the sky used to be regarded as the divisions of the Universe. A definite statement is found in the Vedas to the effect that the region which the clouds, the wind, and the lightning are seen to occupy, is nearer to the earth ; and that the region in which the sun, the moon and the stars appear to move is far away from the earth. Nowhere in the Vedas do we find the division (of the Universe) into Heaven (*Svarga*), the Earth (*Pṛthvī*) and the nether-worlds (*Pātāla*).

From the quotations given above, it appears that the moon was believed to be occupying a position in the sky higher than the sun, and this belief is contrary to scientific truth and to the astronomical theory propounded in post-vedic period. The scientific fact that the actual position of stars is higher up than the sun, is no doubt implicit in the above description. The reason why the moon was believed to be occupying a position higher than the sun was probably the fact that no stars are visible during the day time when the sun shines, and therefore it was possibly believed that the sun had nothing to do with the stars. That is not the case with the moon. Because the stars near which the moon moves are visible and because of its swift motion, it appears to be moving amongst them. Hence, it was but natural for the people to believe that because the stars are higher up than the sun and the moon moves in their region, the moon is also higher than the sun. We, however, get the following quotation from the Vedas confirming the fact that the true position of the moon is nearer to us than the sun and hence lower than the sun.

सुपर्णा एत आसते मध्य आरोधने दिवः ॥
ते सेधंति पथो वृकं तरंतं यह्वतीरपो वित्तं मे अस्य रोदसी ॥ ऋ. सं. १. १०५. ११.

† It is not necessary to give here the original lines which follow this. However, the whole stanza is purposely given with a view to helping correct understanding of the thoughts from context and also because the important astronomical time units viz., the year, the season, the month, the half-month, a "day and night" occur together in one place and because these are given as they actually occur according to their relative order of the whole and its part.

THE MOON'S PLACE

Sāyanācārya, while commenting on the above verse, observes:

"*Yāska pakṣe tvāpa iti antarikṣanāma. Yavhatirapo mahadantarikṣam ....tarantaṁ bṛkam candramasam.*"

This shows that according to Yāska and consequently according to Sāyanācārya also, the lines suggest that the moon is lower in position than the sun, because it moves in the space (sky). The moon is called a 'bird' that is one who traverses the space, in the first verse of this *Sūkta* and this lends an additional support to the view.

THE INFINITENESS OF THE UNIVERSE

The following lines express the idea that the earth as compared with the Universe is very small and the Universe is very expansive.

यदिन्विंद्र पृथिवी दशभुजिरहानि विश्वा ततनंत कृष्टयः ॥
अत्राह ते मघवन् विश्रुतं सहो द्यामनु शवसा बर्हणा भुवत् ॥

ऋ. सं. १. ५२. ११.

"(Oh god Indra !) if the earth were to magnify itself to ten times its size (and if) men would live for eternity, then and then only the glory of your famous might and valour would be equalled by the heaven"—*Ṛk Saṁhitā.*

Here the term 'ten times' is only symbolic. It would be taken to mean many times. The object of the sage in giving this description in the verse is to suggest that the prowess of Indra is very great and it can equal the heaven in greatness. But the life of man who describes it is very short and the earth is also very small in size. If the earth were to grow to a bigger size and if men dwelling on it were to live to eternity, the prowess of Indra will be much extolled and will spread over the infinite universe. What we have to observe is that the idea that the universe is infinitely greater than the earth is clearly stated in this verse.

That the universe is infinite has been described in several places. The passage already quoted from *Taittirīya Saṁhitā* (3.11.1) may be seen as an example of this.

SUN, THE SOLE SUPPORT OF ALL WORLDS

The following lines may be seen as a proof that all worlds are supported by the sun.

सप्त युंजंति रथमेकचक्रमेको अश्वो वहति सप्तनाम ॥
त्रिनाभि चक्रमजरमनर्वं यत्रेमा विश्वा भुवनाधितस्थु : ॥

ऋ. सं. १. १६४. २.

"Seven horses are harnessed to that one-wheeled chariot ; but only one horse bearing '*sapta*' (i.e. seven) names draws it. The wheel has three hubs or navels and it is eternal and unhindered, and all worlds stand supported by it (i.e. chariot)".—*Ṛk Saṁhitā.*

Although the word 'sun' does not occur in the verse it undoubtedly relates o the sun.

सनेमि चक्रमजरं विवावृत उत्तानायां दशयुक्ता वहंति ।।
सूर्यस्य चक्षू रजसैत्यावृतं तस्मिन्नार्पिता भुवनानि विश्वा ।।

ऋ. सं. १. १६४. १४.

"That wheel which traverses only one path and which is indestructible always keeps revolving........It being the sun's eye—it keeps on revolving. All worlds rest upon it."—*Ṛk Saṁhitā.*

मित्रो जनान् यातयति प्रजानन् मित्रो दाधार पृथिवीमुत द्यां ।।
मित्रः कृष्टी रनिमिषाभिचष्टे...

तै. सं. ३. ४. ११.

"*Mitra* (Sun) (knowing the worth of each one) inspires him. *Mitra* supports the heaven and the earth. *Mitra* sees the men and the gods."—*Taittirīya Saṁhitā.*

This verse appears even in the Rigveda, but in a slightly different form. Many more such quotations could be given.

SUN, THE CAUSE OF THE SEASONS

The following line can be cited to show that the sun is the cause of the seasons :—

पूर्वामनु प्रदिशं पार्थिवानामृतून् प्रशासद्विदधावनुष्ठु ।।

ऋ. सं. १. ९५. ३.

"The Sun generates all the earthly directions one by one and controls the seasons."—*Ṛk Saṁhitā.*

Many other quotations could be given to show that the seasons are created by the sun, but they are not given here for want of space. Readers will come across some lines in the study of seasons which forms part of the subject of time units.

SUN, THE CAUSE OF WINDS

That the sun is mainly responsible for the blowing of winds may be seen from the following lines.

सवितारं यजति यत्सवितारं यजति तस्मादुत्तरतः पश्चादयं भूयिष्ठं पवमानः
पवते सवितृप्रसूतो ह्येष एतत्पवते ।।

ऐ. ब्रा. २. ७.

"(The *Hotā*) recites the '*Yājya*, mantras in honour of the sun. The wind blows from north-west because he worships the sun and because the wind blows after being born of the sun."—*Aitareya Brāhmaṇa.*

It is not the intention to maintain that the Vedas hold that the earth and other planets depend upon the sun, because of their attraction by him, and that they revolve round him, but there is no doubt that we do find the idea in the Vedas that the sun is the support of the universe in as much as the seasons are created by him and that all the worlds depend upon him for light, heat and rain.

SEVEN HORSES OF THE SUN

We, no doubt, come across a description of the sun's chariot as having seven* horses. However, statements are by no means wanting in Vedic literature which go to show that it is all metaphorical and that the sun has neither a chariot nor any horses.

अनश्वो जातो अनभीशुरर्वा कनिक्रदत्पतयदूर्ध्वसानु :

ऋ. सं १. १५२. ५.

"The sun born without horses........swiftly jumps high up in the sky :"
—*Ṛk Saṁhitā.*

ONLY ONE SUN AND ONE DAWN

The following verse from Ṛk Saṁhitā will show that there is only one sun and not two, twelve, or many in number.

एक एवाग्निर्बहुधा समिद्ध एकः सूर्यो
विश्वमनु प्रभूतः ॥ एकैवोषा सर्वमिदं विभाति......॥

ऋ. सं. ८. ५८. २.

"Only one sun is the lord of the universe, one dawn gives light to the universe".

It is worth noting that in the above lines, the dawn is said to be only one. The dawn is the twilight before sunrise. At many places in the Vedas, we come across the curious description of there being many dawns, because a dawn is observed every day before sunrise, but the fact was no doubt known that just as there is only one sun, so there is only one dawn permanently associated with him.

THE EARTH, ROUND AND SUPPORTLESS

DAY AND NIGHT

स वा एष न कदाचनास्तमेति नोदेति तं यदस्तमेतीति मन्यंतेऽह्न एव
तदंतमित्वाथात्मानं विपर्यस्यते रात्रीमेवावस्तात् कुरुतेऽहः परस्तादथ
यदेनं प्रातरुदेतीति मन्यंते रात्रेरेव तदंतमित्वाथात्मानं विपर्यस्यतेऽहरे-
वावस्तात् कुरुते रात्रीं परस्तात् स वा एष न कदाचन निम्रोचति।

ए. ब्रा. १४. ६.

"He (i.e. the sun) neither sets nor rises. What is believed to be his set is (as a matter of fact) his turning himself round at the end of the day. He makes night on this side and day on the other. Similarly, what is taken to be his rise in the morning is (as a matter of fact) his turning himself round at the

* Commenting on "Amiye Saptaras mayah", Sri Shanker Pandurang Pandit, the editor of Vedartha Yatna, writes (on page 683, Vol. II, of the issue for April 1878), "that the sun has seven rays is stated here in Ṛk 8-72-16 in clear words. From this it appears that the modern theory of the sun's rays consist of seven colours was not unknown to the Aryans in ancient times".

end of the night, when he makes this day on this side and the night on the other side. In fact he (the sun) never sets.*"—*Aitareya Brāhmaṇa*.

The knowledge of the earth being round in shape and being suspended in space and separated from the sky, is clearly perceived through the above mentioned allusions from the *Brāhmaṇas*. Even in *Gopatha-Brāhmaṇa* (9-10) of the Atharva Veda, we come across lines almost similar in meaning.

It seems that it was known to the people even in the Rigvedic age that the earth is round and stands supportless.

The following verse may be seen

चक्रा गासः परीगहं पृथिव्या हिरण्येन मणिना शुंभमानाः ॥
न हिन्वानासस्तितिरुस्त इंद्रं परि स्पशो अदधात्सूर्येण ॥

ऋ. सं. १. ३३. ८.

"The messengers (of periphery of the earth), who are shining with golden ornaments were unable to vanquish Indra, even when they were flying round the earth's periphery and running with great speed. He then covered** them with sun's light."—*Ṛk Saṁhitā*.

If the earth were flat, the sun's rays, immediately after sunrise, would have fallen at one and the same time on the whole earth, or at least on half of its surface; but references show that the rays instead of falling at once, do so one after the other. The following verse may be seen :—

आप्रा रजांसि दिव्यानि पार्थिवा श्लोकं देवः कृणुते स्वाय धर्मणे ॥
प्र बाहू अस्राक् सविता सवीमनि निवेशयन् प्रसुवन्नक्तुभिर्जगत् ॥

ऋ. सं. ४. ५३. ३.

"The brilliant sun filled with light the regions of the heaven, the space and the earth."—*Ṛk Saṁhitā*.

The sun is rising and stretching out its arms, putting the world to sleep by turns and awakening it by turns by means of its lusture.

The mantra "the sun rises causing a gradual sleep and a gradual awakening" may be taken to mean that as the sun traverses the sky, there is nightfall in some parts of the world which are thus enveloped in darkness; and because it gradually throws light on some other parts, there is day time there. This betokens a knowledge of the roundness of the earth.†

Any such references in the Vedas as to show the earth as having been divided into *Meru-mountain*, *Jambudvīpa* and other seven islands can not perhaps be found.

* The speaker is observing this with respect to his own place. The words "this side" refer to the side on which he stands with respect to the sun. By the words "turns himself round" he means to say that the sun, after moving in one direction till evening, changes his direction after dawn after sunset.

**Commenting on this verse, Shri Shanker Pandurang Pandit the editor of Vedarth-Yatna, observes (Vedarth Yatna, Page 380, Vol. I), that "The words "Parinaham chakranasha" clearly show that our Aryan ancestors, at the time of composing these verses doubtless knew that the earth is not flat but round spherical in shape".

† It is clear that the Saṁhitās of all the Vedas, the Brāhmaṇa works and the Upaniṣads were not compiled in the same age. It is very difficult to assign limits to their times.

(*contd. to next page*)

So far we have considered as to what is found in the Vedas about the creation of the world and the structure of the universe. Let us now see what do we find about the units of time like the year, the month etc., the positions and motions of the sun and the moon, the stars, eclipses, planets, etc.

UNITS OF TIME

THE KALPA.—Let us first consider the 'time-units'. The term *Kalpa* used as one of the time units in the astronomical works of post-Vedic period, not only does not find a place in the Vedas, but also the word *Kalpa* is not found having anywhere been used in the Vedas in the sense of some kind of time-unit.

THE YUGA.—The word *Yuga* has occurred in several places in the Vedas, where it denotes some unit of time. As it would be convenient to consider this subject properly, all those references which contain the word *Yuga* or the names of any of the four *Kṛtādi Yugas* are given below.

देवानां पूर्व्ये युगेसतः सदजायत ॥

ऋ. सं. १०. ७२. २.

तदूचुषे मानूषेमा युगानि कीर्तेन्यं मघवा नाम बिभ्रत् ॥
उपप्रयंदस्युहत्याय वज्री यद्ध सूनुः श्रवसे नाम दधे ॥

ऋ. सं. १. १०३. ४.

"*Maghavā* (*Indra*) adopted the same famous name for the *Stotas* in this *humanyuga*, which the very mighty *Indra* had adopted when he marched with the thunderbolt in his hand to kill *Dasyu.**"—*Ṛk Saṁhitā.*

Sāyanācārya observes that the word *yuga* has to be taken to mean the four Kṛtādi yugas.

विश्वे ये मानुषा युगा यांति मर्त्यं रिषः ॥

ऋ. सं. ५. ५२. ४.

ईर्मान्यद्वपुषे वपुश्चक्रं रथस्य येमथुः ॥
पर्यन्या नाहुषा युगा मन्हारजांसि दीयथः ॥

ऋ. सं. ५. ७३. ३.

"Oh Aśvins ! you revolve round the worlds ....with the second wheel of your chariot."—*Ṛk Saṁhitā.*

दीर्घतमा मामतेयो जुजुर्वान् दशमे युगे ॥
अपामर्थं यतीनां बृह्मा भवति सारथिः ॥

ऋ. सं. १. १५८. ६.

The period can however be divided into (i) The Saṁhitā age, (ii) The Brāhmanic age and (iii) The Upaniṣad age. and their sub-divisions would be too many to mention. Instead of dividing the time into several parts for the sake of drawing a few conclusions regarding the astronomical knowledge of that period, it is convenient to leave it to the readers after simply mentioning the works from which those Vedic references have been taken, and that is why all these references in the Vedic period have been included. It is needless to say that the 'Brāhmaṇas' are more ancient than the 'Upaniṣads', and the 'Saṁhitās' and specially the Ṛk Saṁhitā are the most ancient.

*In translating the Vedic mantras the author has strictly adhered to the original and nothing has been added which does not exist in the original text.

"*Dīrghatamā*, the son of *Mamatā*, having grown old in the 10th yuga, became the charioter (in the form of *Ritvik*) of the *Karma* (action) which leads to some (divine) result".—*Ṛk Saṁhitā.*

Sāyana, in his commentary on the above verse, says that Dīrghatamā after happily passing his life for 10 yugas through the grace of Ashwees, finally attained old age. He does not state in clear words what a 'yuga' should be taken to mean, still the context of his writing suggests that it should be interpreted as ten kṛtādi yugas.

युगे युगे विदध्यं गृणद्भ्योग्नेरयिं यशसं धेहि नव्यसीं ॥

ऋ. सं. ६. ८. ५.

"Oh God of fire (agni) ! Give riches and success to us who offer new words of praise to thee for the sake of sacrifices in each yuga".—*Ṛk Saṁhitā.*

या ओषधीः पूर्वा जाता देवेभ्यस्त्रियुगं पुरा ॥

ऋ. सं. १०. ९७. १.

"The herbs which created by Gods in three yugas before"—*Ṛk Saṁhitā.*

In his commentary on the above line Sāyanācārya interpreted the word *Triyuga* as either the three yugas *Kṛta*, *Tretā* and *Dvāpara* or the three seasons *Vasanta* (Spring), *Varṣā* (Rains) and *Śarad* (Autumn).

The same mantra occurs even in Taittirīya Saṁhitā in the form—

या जाता ओषधयो देवेभ्यस्त्रियुगं पुरा ॥

Even in Vājasaneyī Saṁhitā the same *mantra* is found in the following form, and Mahīdhar, the commentator has interpreted the word 'Yuga' as the three seasons—spring, rains and autumn :—

या ओषधीः पूर्वा जाता देवेभ्यस्त्रियुं पुरा ॥

A reference to the word 'Yuga' is made in Vājasaneyī Saṁhitā in the following line :—

श्रुत्कर्णं ८० सप्रथस्तमं त्वागिरा दैव्यं मानुषा युगा ॥

वा. सं. १२. १११.

In all these references the word *yuga* has undoubtedly been used to denote some unit of time, but none of them clearly indicates the number of years which the word is supposed to denote. In the Vedāṅga Jyotiṣa, a *yuga* is supposed to be a unit of 5 years. It cannot, however, be said for certain that the word is definitely used in the same sense as in the above lines, nor can it be said for certain that it is not so used; for it will be seen later on that the names *Saṁvatsara*, *Parivatsara*, etc., which form parts of the five-yearly *yuga* of the Vedāṅga Jyotiṣa do occur in the Vedas.

In the quotation "Dīrghatamā became old in the tenth *yuga*" it is not the object of the writer to point out some infirmity of Dīrghatamā. It is clear that he intends to express some speciality about him; and if it be taken to mean units of 5 years it would on the other hand show his infirmity, as he would be regarded to have attained old age at fifty. Therefore, instead of assuming that the span of life was a thousand years, if it be assumed as of some limited number of years, say a hundred years, the term *yuga* has to be taken to mean at least a period of ten years. From this and from the Rigveda quotation "We praise you in new terms in every *yuga*", it appears that the *yuga* must have been a unit of time smaller than the span of human life, that is smaller than 100

years. It cannot, however, be said that the idea of a *yuga* representing a much longer period of time, never existed. The remarks "It so happened before in the divine age", "the human ages of the present time" cannot emanate from a speaker unless he has in his mind that a *yuga* does indicate an abnormally long period of time.

It must be said that the word yuga had no standard meaning and consequently it has to be believed that even in the Vedic times it must have had its meaning in the general astronomical sense of a "period of time after which a phenomenon occurring once repeats itself in the same order". The eclipses of the sun and the moon which occur in some order or at certain intervals during a period of eighteen years, recur in the same order and at the same interval, so as to be visible at some place or the other on the earth; this can, therefore, be said to be a sort of an 'eclipse-yuga' of 18 years. It is clear from the Vedāṅga Jyotiṣa and from other examples that the word *yuga* has bene used in astronomy in accordance with the principle underlying this sense. All planets come together at the commencement of each of the four yugas and of the Mahāyuga, and after making a number of revolutions in each yuga they come together again in the beginning of the next yuga. This period is termed a 'yuga' and though the yuga is employed in the astronomical works in the sense of a period of 432,000 years or its multiples, it is found used even in its original sense. For instance, in the *Bhaṭaprakāśikā*, a commentary by Sūrya Deva Yajva on the work of Āryabhaṭa I, the following lines give the measures of the *yugas* of the nodes and aphelia of planets :—

खाकाशाष्टकृतद्विद्विव्योमेष्वद्रीषुवन्हयः ।। युगं बुधादिपातानां...।। ३५७५०२२४८००.

रव्युच्चस्य रसैकांकगिर्यष्टिनवशंकराः ।। सहस्त्रघ्ना युगं प्रोक्तं...।। ११९१६७९१६०००.

"The yuga (cycle) of the node of Mercury consists of 35,750,224,800 years and that of the sun's apogee of 119,167,916,000 years." The number of years for each is of course different, which shows that the word 'yuga' is used in the above lines to denote the periodic measure of time after which a phenomenon recurs. Hence, after reading the Vedic verses one is inclined to think that the word yuga must have been used in these lines, in its original sense and the measures of time indicated by the word must have been used in these lines in its original sense and the measures of time indicated by the word must have been different for different phenomena. It cannot, however, be said as to what was the actual measure of time and what was the recurrent phenomenon on which it depended; and although the definition of Mahāyuga meaning 4,320,000 years has not come in vogue in the Vedic age, yuga was no doubt used in the sense of some very lengthy measure of time. Not only this, but that the idea that the yugas were four in number was prevalent at the time of compilation of the three Vedas, can also be clearly seen from the line "*Yā jātā oṣadhayo devebhyaḥ triyugaṁ purā*".

KṚTA AND OTHER WORDS OCCURRING IN THE VEDAS

Now the lines in which the words Kṛta and Tretā occur are quoted below from *Taittirīya Saṁhitā* :—

प्राची दिशां वसंत ऋतूनामग्निर्देवता ब्रह्म द्रविणं त्रिवृत्सोमः स उ पंचदश वर्तनिस्त्रयविर्वयः कृतमयानां...त्रेतायानां...द्वापरोयानां...आस्कंदोयानां...अभिभूरयानां पितरः पितामहाः परेवरे ते नः पांतु तेनोवंत्वस्मिन ब्रह्मन्नस्मिन्क्षत्रस्यामाशिष्यस्यां पुरोधायामस्मिन्कर्मन्नस्यां देवहूत्यां ।।

तै. सं. ४. ३. ३.

It will be seen that just as a prayer, 'May the manes, etc., protect us' occurs at the end of the stanza, the prayer 'May *Kṛta* and *Dvāpara* protect us' also does appear there.

कृतायादिनवदर्शं त्रेतायै कल्पिनं द्वापरायाधिकल्पिनमास्कंदाय सभास्थाणुं ।

वा. सं. ३०. १८.

"*Ādinavadarśa* is to be offered to Kṛta, *Kalpi* to Tretā, *Adhikalpi* to Dvāpara and *Sabhāsthānu* to *Āskanda*"—*Vājasaneya Saṁhitā*.

The commentator Mahīdhara renders 'Ādinavadarśa' as one who can see fault known as *Ādinava*, and 'Kalpi' as one who imagines. The Taittirīya Brāhmaṇa gives a similar but slightly different line under 'Puruṣamedha', which runs thus :—

कृत्राय सभाविनं ॥ त्रेताया आदिनवदर्शं ॥ द्वापराय बहिःसदं ॥ कलये सभास्थाणुं ॥

तै. ब्रा. ३. ४. १.

"A *Sabhāvi* should be procured for Kṛta, an *ādinavadarśa* should be offered to Tretā, *bahiḥsada* to Dvāpara and a *sabhāsthānu* to Kali"—*Taittirīya Brāhmaṇa*.

This stanza names the 'sacrificial persons' which should be offered to different deities. The commentary by Mādhava gives the meanings of these terms as follows :—

'Sabhāvi' is one who sits in the gambling hall; an 'ādinavadarśa' is the observer examiner of the game (of gambling) ; a 'bahiḥsada' is the one who witnesses the game without taking part in it, and a 'sabhāsthānu' is the one who does not leave the hall even when no game is being played.

The story of Hariścandra occurs in the Aitareya Brāhmaṇa. Hariścandra had no son. He invoked god *Varuṇa* to grant him a son, promising that the son would be offered to him in sacrifice. He then got a son who was named Rohita. After some years when the son was being sacrificed, he ran away into a forest. After wandering in the forest for a year he returned to his village. At that time, Indra, taking a human form, met him and advised him to return to the forest. This happened repeatedly for four years. When Rohita returned again, Indra said to him'.

कलिः शयानो भवति संजिहानस्तु द्वापरः ॥
उत्तिष्ठँस्त्रेता भवति कृतं संपद्यते चरँश्चरैवेति चरैवेति ॥

ऐ. ब्रा. ३३. १५.

"One who sleeps becomes Kali, one who sits becomes Dvāpara, one who gets up becomes Tretā, and one who becomes a wanderer attains Kṛta. Therefore keep on roving, keep on roving."—*Aitareya Brāhmaṇa*.

ये बै चत्वारः स्तोमाः ॥ कृतं तत् ॥ अथ ये पंच ॥ कलिः सः ॥ तस्माच्चतुष्टोमः ॥

तै. ब्रा. १. ५. ११.

"The four *stomas* are Kṛta and five are Kali and hence the *Jyotistoma* sacrifice should be *Catuṣṭoma*"—*Taittirīya Brāhmaṇa*.

This gives a limit to the number of 'stomas' *i.e.* (oblations). Some say five and some only four. Offering five would be Kali which is bad and offering four would be Kṛta which is good, and that is why the rule of offering four has been stipulated.

It can not be proved that the words Kṛta, etc. have been used in the definite of time; still the idea that they represent four deities is quite

clear from the above sentences. Similarly, the belief that Kṛta indicated something good, and others were increasingly inferior, Kali being the worst, is also indicated in these sentences. As it is evident from several lines in the Vedas that yugas were regarded as units of time and they were believed to be four in number, there is no doubt that the origin of the deeply rooted views about the yugas in the post-Vedic age lies in these very lines from the Vedas in which the terms Kṛta and others occur. The word Dvāpara occurs in *Gopatha Brāhmaṇa* (1·28) in the sense of a unit of time.

THE FIVE-YEAR CYCLE

In the Vedāṅga Jyotiṣa the yuga is taken to be a cycle of five years. The names of these years are *Saṁvatsara, Parivatsara, Idāvatsara, Anuvatsara* and *Idvatsara.* Although these names do not occur in the Vedāṅga Jyotiṣa itself, there is no doubt that these were the names of the years, in as much as they occur in the Vedas, and writers like Garga and others have given these very names. Let us see what the Vedas state about this :—

संवत्सरस्य तदहः परिष्ठयन्मंडूकाः प्रावृषीणं बभूव ॥
ब्राह्मणासः सोमिनो वाचमक्रत ब्रह्मकृण्वंतः परिवत्सरीणं ॥

ऋ. सं. ७. १०३. ७, ८.

It can not be definitely said that the words *Saṁvatsara* and *Parivatsasa* have been given in this verse to show that this is the correct order of the names, still it is certain that the names did occur in this very order. And looking into the fact that when any thing is to be said about the year in a general sense, the word year is generally rendered in the Rigveda by some such words as *Śarad, Hemanta,* etc. which denote a season, it is thought that the above words must be the names of two of the years comprising the five-year cycle. The word *Parivātsara,* however, occurs in the Rigveda at one more place (10-62-2); the names of the other three years are nowhere to be found.

संवत्सरोसि परिवत्सरोसीदावत्सरोसीद्वत्सरोसि वत्सरोसि

वा. सं. २१. ४५.

संवत्सराय पर्यायिणीं परिवत्सरायाविजातामिदावत्सरायातीत्वरी-
भिद्वत्सरायातिष्कद्वरीं वत्सराय विजर्जरां संवत्सराय पलिक्नीं ॥

वा. सं. ३०. १५.

This *mantra* occurs in *Puruṣamedha* and states what particular kinds of women are to be offered to Saṁvatsara, Parivatsara, Idāvatsara, Idvatsara and Vatsara. In both the *mantras* from Vājasaneyī Saṁhitā, the order of the names of five years is the same. The second *mantras* mention the name Saṁvatsara again after giving the five names beginning with Saṁvatsara.

The Taittirīya Brāhmaṇa gives the following lines :—

अग्निर्वाव संवत्सरः । आदित्यः परिवत्सरः । चंद्रमा इदावत्सरः ॥ वायुरनुवत्सरः ।

तै. ब्रा. १. ४. १०.

"Agni (fire) is the Saṁvatsara, Āditya (the sun) the Parivatsara, Candramā (the moon) the Idāvatsara, and Vāyu (wind) the Anuvatsara."
—*Taittirīya Brāhmaṇa.*

These lines mention only four names. Of these, the first three are given in the same order as in the Vājasaneyī Saṁhitā and the fourth is Anuvatsara which is different therefrom.

Taittirīya Brāhmaṇa says,

संवत्सराय पर्यारिणीं । परिवत्सरायाविजातां । इदावत्सरायापस्कद्वरीं ॥
इद्वत्सरायातीत्वरीं । वत्सराय विजर्जरां ॥ संवत्सराय पलिक्नीं ॥
तै. ब्रा. ३. ४. १

An almost equivalent quotation from the Vājasaneyī Saṁhitā has already been given above. Both of them give the same order of year-names; there is, however, some difference in respect of the animals to be offered in the sacrifice. Even in these lines there is the repetition of the name Saṁvatsara at the end after the mention of the usual five names.

संवत्सरोसि परिवत्सरोसि ॥ इदावत्सरोसीदुवत्सरोसि ॥ इद्वत्सरोसि वत्सरोसि ॥
तै. ब्रा. ३. १०. ४.

A similar quotation from the Vājasaneyī Saṁhitā has been given above. This gives the additional name of *Iduvatsara* as the fourth year, thus making the total period consisting of six years.

Mādhavācārya, however, interpretes Iduvastsara as a synonym for Anuvatsara.

Apart from this the names like Saṁvatsara, Parivatsara and other names are found in many places in the Taittirīya and Vājasaneyī Vedas.

These passages mention a varying number of years, some of them mention five, others six, while some others only four and these too have been given in a different order every time. It cannot be definitely said whether these represent the five yearly cycle which was current in the Vedāṅga Jyotiṣa age. However, the reference to the 5-year cycle and the names of years comprising it in the post-Vedic works which occurs at several places must have had some support of tradition.

In short, it seems that a system, similar in many respects to the 5-year cycle system of the Vedāṅga Jyotiṣa must have been in use in the Vedic age.

THE YEAR

Let us now consider the connotation of the two terms, the year and the month. The word *Varṣa* which at present denotes a unit of 364 or 365 days or some such interval, is not found in the same sense in the Ṛk-Yaju-Saṁhitās or the Aitareya, the Taittirīya, the Tāṇḍya or the Gopatha Brāhmaṇas, but it does occur in the Śatapatha Brāhmaṇa (2-2-3). In Rigveda, the names of seaons like Śarad have been for use denoting a year. Similarly, the words Saṁvatsara and Parivatsara are found so used in some places. In both the versions of the Yajurveda words like Śarad and Hemanta have not only been used several times in the sense of a year, but the word Saṁvatsara appears to have been used much more frequently. The word '*hāyana*' has been used in

the sense of a year in the Gopatha Brāhmaṇa (6-17). The word *'samā'* has also been used in the sense of a year in the Vājasaneyī and Ṛk Saṁhitās. The following *mantras* may be cited in this respect :—

तेषाँ श्रोमंयिकल्प्यतामस्मिन् लोके शतँसमाः ॥ वा. सं. १९. ४६.

कुर्वन्नेवेहकर्माणि जिजीविषे शतं समाः ॥ वा. सं. ०. ४०. २.

समानां मास आकृतिः ऋ. सं. १०. ८५. ५.

Months were Lunar

It was but natural that in the Vedic age the months were lunar, and it is needless to give here any quotations in support of this. Some of them will be given when the study of the 'month' would be exclusively taken up. The term *'Pūrṇamāsī'* which is applied to full moon days and which literally means "the *tithi* on which the month ends" is well known. It has already been pointed out that the term *'māsa'* which was originally a synonym for the moon was later applied to the time-unit of a month. No convenient means is available for measuring a solar month like the lunar one, which is naturally measured by the moon. The measure of a solar month can generally be known only by calculations. Therefore, it is clear that at the beginning man must have adopted the lunar month for their use and that the solar month came into being afterwards.

The Year was Solar

The first impression would be that because the months* were lunar, the year also must have been lunar. It is, therefore, to be considered whether the year was a lunar or a solar one ; and if solar, whether it was sidereal or tropical. The following quotations clearly mention the measure of a year in terms of days or months.

वेदमासो धृतव्रतो द्वादश प्रजावतः ॥ वेदा य उपजायते.

ऋ. सं. १. २५. ८.

"Dhṛtavrata (Varuṇa) knows the twelve months ; (and) the animals created during that period ; (and) he knows (the intercalary month) which is created (near the twelve months)"—*Ṛk Saṁhitā*.

Although the word 'intercalary' has not been explicitly stated here, it is clear from the context that the intercalary month is intended and this '*Ṛc*' is rendered in this very sense traditionally. The western scholars also accept this sense. That the year commonly consists of twelve months has been clearly stated in this Ṛc.

द्वादशारं नहितज्जराय वर्वर्ति चक्रं परिद्यामृतस्य ॥

आ पुत्रा अग्ने मिथुनासो अत्र सप्त शतानि विंशतिश्च तस्थुः ॥

ऋ. सं. १. १६४. ११.

*This statement may appear vague, because only the term 'year' is under consideration here. A study of the civil, lunar and solar months will be taken up later.

"The wheel (of time) having twelve spokes revolve round the heavens, but it does not wear out. Oh Agni ! 720 pairs of sons ride this wheel"—Ṛk. Saṁhitā.

द्वादश प्रधयश्चक्रमेकं त्रीणि नभ्यानि क उ तच्चिकेत ।।
तस्मिन्त्साकं त्रिशता न शंकवोऽर्पिताः षष्टिर्न चलाचलासः ।।
ऋ. सं. १. १६४. ४८.

"Twelve spoke-boards, one wheel, three navels. Who understands these? In these there are 360 Śaṅkus (rods) put in like pegs which do not get loosened"—Ṛk. Saṁhitā.

It is clear that this curious description refers to the year, the 12 months are the twelve spokes of the wheel and the 360 days are the 360 nails. 'The day and night' is a couple and 360 such couples give the number 720.

मधुश्च माधवश्च शुक्रश्च शुचिश्च नभश्च नभस्यश्चेषश्चोर्जश्च सहश्च
सहस्यश्च तपश्च तपस्यश्चोपयामगृहीतोऽसि संसर्पोस्यँ हस्पत्याय त्वा ।।
तै. सं. १. ४. १४.

"Oh Soma (Juice) ! You are taken in by the 'upayāma' (*i.e.* a dish, a pan). You are Madhu, you are Mādhava, you are Śukra, etc."—*Taittirīya, Saṁhitā.*

This gives the following names of the twelve months ; Madhu, Mādhava, Śukra, Śuci, Nabhas, Nabhasya, Iṣa, Ūrja, Sahas, Sahasya, Tapas and Tapasya. It also gives *Saṁsarpa* as the name of the intercalary month. Mādhavācārya, while commenting on the above lines, observes that the word *Aṁhaspaṭi* means the suppressed or decayed month.

मधुश्च माधवश्च वासंतिकावृतू शुक्रश्च शुचिश्च ग्रैष्मावृतू नभश्च नभस्यश्च वार्षिका-
वृतू इषश्चोर्जश्च शारदावृतू सहश्च सहस्यश्च हैमंतिकावृतू तपश्च तपस्यश्च शैशिरावृतू ।।
तै. सं. ४. ४. ११.

"Madhu and Mādhava are the (two) months* of spring ; Śukra and Śuci of summer ; Nabhas and Nabhasya of the rainy season ; Iṣa and Ūrja of autumn ; Sahas and Sahasya of late autumn ; and Tapas and Tapasya of sisira (winter)—*Taittirīya Saṁhitā*."

षड्रात्रीर्दीक्षितः स्यात् षड् वा ऋतवः संवत्सरः ......
द्वादश रात्रीर्दीक्षितः स्यात् द्वादश मासाः संवत्सरः ......
त्रयोदश रात्रीर्दीक्षितः स्यात् त्रयोदशमासाः संवत्सरः ......
पंचदशरात्रीर्दीक्षितः स्यात्पंचदश वा अर्धमासस्य रात्रयो-

*The word 'Ṛtu' appears to have been used in sense of a 'month' in the original.

धंमासशः संवत्सर आप्यते......चतुर्विंशतिं रात्री-
दीक्षितः स्याच्चतुर्विंशतिरर्धमासाः संवत्सरः......
त्रिंशतं रात्रीर्दीक्षितः स्यात् त्रिंशदक्षराविराट्
मासं दीक्षितः स्याद्यो मासः स संवत्सरः ॥

तै. सं. ५. ६. ७.

"One should remain consecrated for six nights, because there are six sea sons in a year............ Consecration should be observed for twelve nights b cause there are twelve months in a year........... Consecration should las for 13 nights because the year has 13 months* etc."—*Taittirīya Saṁhitā.*

तस्य त्रीणिच शतानि षष्ठिश्च स्तोत्रीयास्तावतीः संवत्सरस्य रात्रयः

तै. सं. ७. ५. १.

"It has 360 '*Stotriyas*' because the year has so many nights."—*Taittiirīy Saṁhitā.*

उपयामगृहीतोसि ॥ मधवे त्वोपयामगृहीतोसि माधवाय
त्वोपयामगृहीतोसि शुक्राय त्वोपयामगृहीतोसि शुचये...
नभसे...नभस्याय...इषे...ऊर्जे...सहसे...सहस्याय...तपसे...
तपस्याय...अंहसस्पतये त्वा । वा. सं. ७. ३०.

"(Oh Ritugraha !) You have been adopted by 'Upayāma' (*i.e.* a dish) fo the Madhu............."—*Vājasaneyī Saṁhitā.*

Some of the lines quoted from Taittirīya Saṁhitā (1·4·14) are almost similar to those given above. These contain similar names of the twelve months of the year, *viz.*, Madhu, Mādhava, etc., but the last verse names the thirteenth month as '*Aṁhaspati*'.

The quotations "Madhusca Mādhavasca..........." from Taittirīya Saṁhitā are found in Vājasaneyī Saṁhitā also (*see* 13. 25, 14.6,15,16,27 and 15,57).

सं सर्पाय स्वाहा चंद्राय स्वाहा ज्योतिषे स्वाहा मलि-
म्लुचाय स्वाहा दिवापतये स्वाहा वा. सं. २२. ३०.

मधवे स्वाहा माधवाय स्वाहा शुक्राय स्वाहा शुचये
स्वाहा नभसे स्वाहा नभस्याय स्वाहेषाय स्वाहोर्जाय
स्वाहा सहसे स्वाहा सहस्याय स्वाहा तपसे स्वाहा
तपस्याय स्वाहांहसस्पतये स्वाहा ॥

वा. सं. २२. ३१.

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*The translation of the above passage has been partly omitted in the text because it is not necessary for explaining the point. It is now given in full below.

" One should remain consecrated for 15 nights. Half a month has 15 nights. A year is made up of half-months. Remain consecrated for 24 nights, because 24 half-months make a year. Remain consecrated for 30 nights, because thirty *Akṣaras* make the *Virāṭ*. One should remain consecrated for a month because a month is a year". Here a distinction is made between 30 days and a month. Similarly, looking to the reasons put forward for the observance of a period of a particular number of nights, one would expect the author to recommend the adoption of a period of 30 nights, on the plea that a month consists of 30 nights, but it is not so stated. Hence it appears beyond doubt that in the Vedic age, the lunar month was known to be slightly shorter than the period of thirty *Sāvana* (civil) days.

The above lines first give the terms *Saṁsarpa, Malimluca* (now usually given as a synonym for the intercalary month) followed by Madhu and other names of 12 months, and then comes the thirteenth name '*Aṁhaspati*'. This shows that *Saṁsarpa, Malimluca* and *Aṁhaspati* must have some differences in their meanings.

तं त्रयोदशान्मासादक्रीणंस्तस्मात् त्रयोदशो मासो नानुविद्यते

ऐ. ब्रा. ३. १.

"They purchased 'Soma' juice from the thirteenth month, and hence the thirteenth month is censurable".—*Aitareya Brāhmaṇa.*

त्रीणिच वैशतानि षष्टिश्च संवत्सरस्याहानि...सप्त च वै
शतानि विंशतिश्च संवत्सरस्याहोरात्रय: ऐ. ब्रा: ७. १७.

"A year has 360 days, a year has 720 days and nights together".

द्वादशारत्नी रशना कर्तव्या ३ त्रयोदशारत्नी३रिति ॥ ऋषभो वा एष ऋतूनां ॥ यत्संवत्सरः ॥ तस्य त्रयोदशो मासो विष्टपं ॥ ऋषभ एष यज्ञानां ॥ यदश्वमेधः ॥ यथा वा ऋषभस्य विष्टपं ॥ एवमतस्य विष्टपं ॥ तै. ब्रा. ३. ८. ३.

"Should the reins in a horse-sacrifice be twelve cubits in length or thirteen? The year consisting of (six) seasons is a kind of bullcck whose hunch is the thirteenth month. The horse-sacrifice is the best of all sacrifices. The year in the form of a bullock has got a hunch (in the form of the 13th month)".—*Aitareya Brāhmaṇa.*

It is clear from the above quotations that the year was solar in the Vedic age. The natural means of measuring a year used to be one complete cycle of seasons, just as the natural means of measuring a day was the period between two consecutive sunrises or that for measuring a month used to be the period between two full moons. The year as a unit of time could not have come into existence if seasons were not to exist. It is, therefore, obvious that the year must have been solar. During the earliest stages of observation, the seasons were naturally supposed to recur after 12 lunar months. Although, one complete cycle of seasons required 11 days more than 12 lunar months, it must have been difficult to guess this correct measure in the beginning and one year must have been supposed to consist of 12 lunar months for a considerable period of time. As a result of this supposition, however, the month which used to fall in summer must have shifted to occur in winter and later on in the rainy season and thus have gradually receded through all the seasons. Every month of that calendar, like the Muharram of the Muslims, was bound to pass through all the seasons, thus completing a revolution in 33 years. After the passage of several such cycles of 33 years, it must possibly have occurred to people to insert an intercalary month; and the fact that such an intercalary month used to be reckoned in the Vedic times goes to prove that the year was solar in those days. This may appear very trivial today, but it certainly was no ordinary matter that our people conceived the idea of inserting an intercalary month in those days of hoary antiquity. As a matter of fact it is extremely significant.

The ancient Romans who at one time were a very powerful nation used to regard a year as consisting of 10 months for quite a long time. Some of those parts of the Vedas which contain references to intercalary months were compiled before 1500 B. C. Even European scholars accept this view. The reference to intercalary months has not been made in such passages as a matter of special or unusual interest. It, therefore, appears that the idea had become a matter of common experience long before that time.

Now there is no clue to find out the number of months that used to lapse before the intercalary month was inserted. According to the current practice an intercalary month is inserted after about 32 or 33 months by mean reckoning. The figure would vary by a month or two if true motions are taken. Even then it occurs after 32 or 33 months on an average. It used to occur after 30 months according to the Vedāṅga Jyotiṣa. It is not known after how many months an intercalary month used to occur in the Vedic age. However, there must have been some rule for this.

The terms 'Malimluca', 'Saṁsarpa' and 'Aṁhaspati' occur in the lines quoted above. The following lines show that the intercalary month is known as 'Malimluca'.

रविणा लंघितो मासश्चांद्रः ख्यातो मलिम्लुचः

—व्यासः

"The lunar month which is skipped over by the sun is known as *Malimluca*" —*Vyāsa.*

मासद्वये यदाप्येकराशिं संक्रमेतादित्यस्तत्राद्यो मलिम्लुचः शुद्धोन्यः

—मैत्रेयसूत्र.

"When the sun is found to cross only one *Rāśi* in two months the former is called the *Malimluca* and the latter the *Śuddha* or proper"—*Maitreya Sūtra.*

The terms Saṁsarpa and Aṁhaspati are defined as :

असंक्रांतिद्विसंक्रांती संसर्पांहस्पती समौ

—नारदसंहिता.

This shows that the *Asaṁkrānti* or intercalary month was called 'Saṁsarpa' and the *Dvisaṁkrānti* or missing month as 'Aṁhaspati'.

The author of *Muhūrta Cintāmaṇi* has, in Chapter I, verse 47, described the characteristics of the above two months as follows :—

'When missing month occurs, two intercalary months also occur in that year. The one preceding it is to be known as *Saṁsarpa* and the one following it as *Aṁhaspati*'. It is not known if the terms carried some such meaning in the Vedic age.

It has been shown that the year was solar. Whether it was tropical solar or sidereal solar will be considered later on.

THE MEASURES OF SĀVANA LUNAR AND SOLAR YEARS

Let us see whether any kind of year other than the solar was in use. Out of the five astronomical measures of time viz. Sāvana (sacrificial), lunar, solar, sidereal and Jovian, no description of either the sidereal or the Jovian year is found in clear or even in implicit terms in the Vedic literature. The remaining three terms will now be considered.

The period between two consecutive sunrises is known as *Sāvana* day. The term Sāvana has its origin in the '*Soma*-sacrifice'. In a 'soma sacrifice' the 'soma' juice has three *'savanas' i.e.*, it is offered three times during the period of 'a day and a night'. This idea is expressed by Mādhavācārya in his work "*Kāla Mādhava*" as follows :—

सावनशब्दोऽहोरात्रोपलक्षक: सोमयागे सवनत्रयस्याहोरात्रसंपाद्यत्वात् ।

Therefore, that which pertains to 'savana' is sāvana, that pertaining to 'candra' (moon) is cāndra and that which pertains to the sun is 'saura' (*i.e.* solar).

The soma-sacrifice which is completed in one day of 24 hours is known as '*aha*' in the Vedas (and it appears that the day also used to be known as 'aha'). A group of such six 'aha's is known as '*ṣaḍaha*' and five such ṣaḍahas make a 'māsa' or a month. Several such ṣaḍahas and māsas are required to be observed in a *samvatsara-satra i.e.* an annual sacrifice; and all of them together make 360 days. (In addition to these, the *viṣuvān* or equinoctial day falls in the midst of these days.) Mādhavācārya says :—

अहोरात्रसाध्य: एक: सोमयागो वेदेष्वह: शब्देनाभिधीयते तादृशानामहर्विशेषाणां गण: षडह:...
षडहेन पंचकेन एको मास: संपद्यते तादृशैर्द्वादशभिर्मासै: साध्यं संवत्सरसत्रं ॥

कालमाधव.

This and other similar quotations go to show that the 'Sāvana' year was in use for sacrificial purposes; and it must have been in use in day to day affairs, for it was easier to measure it than the solar or the lunar year.

It has already been shown on page 17 that the months were lunar; consequently a lunar year also must have been in vogue. Its congruance with the solar year, however, used to be made up by the insertion of an intercalary month.

It seems to have come to notice that the lunar year did not consist of 360 days but was somewhat shorter.

Proofs have already been adduced (see foot-note on page 19) in support of the argument that a lunar month was noticed to be not exactly equal to 30 days. There is a sacrifice known as *Utsargiṇāmayana* which is another form of *Gavāmayana* sacrifice. A stanza from the *Taittirīya Saṁhitā* relating to it quotes the line.

षडहैर्मासांत्संपाद्याहरुत्सृजंति

तै. सं. ७. ५. ६.

meaning "a day is omitted after some *saḍahas* and *māsas* are observed". It indicates the circumstances under which a day is to be omitted during the period when a sacrifice continues. Because a lunar month is equivalent to 29 ½ days, two such months would be equivalent to 59 days. Therefore, if a '*saḍaha*' sacrifice is commenced on the first day of a lunar month, the second lunar month would end one day earlier than the completion of two sacrificial months (*i.e.* 60 days). The sacrificial priests, after actually noticing this discrepancy, must have felt the need for omitting* one day from one

*Mādhavācārya writes about this 'omission' in *Kālamādhava* :—

द्वादशमासेष्वनुष्ठेयायां प्रकृतौ चैकस्मिन् मासे त्रिंशत्स्वहत्सु सोमयागविशेषाणां त्रिंशतामनुष्ठेयत्वात् न किंचिदहरुत्स्रष्टुं शक्यते तद्वद्विकृतावपि प्राप्ते प्रतिमासमेकस्मिन्नहनि सोमयागपरित्यागो विधीयते ॥ तत्र कतमदहस्त्यज्यतामिति वीक्षायामिदं (अमावास्ययामासान् संपाद्याहरुत्सृजंति......) उच्यते ॥

of the *sadahas* and this must have resulted in the introduction of the '*utsargiṇāmayana*' sacrifice.

The reason for omitting a day has been given in the *Tāṇḍya Brāhmaṇa* as follows :—

यथा वै दृतिराध्मात एवसंवत्सरोनुत्सृष्टः

तां. ब्रा. ५. १०. २.

"If a day is not omitted the year will swell like the bellows made of leather".

The line '*utsrijyām notsrijyā*' given in the stanza following the one in which the lines quoted above occur shows that the Brahmavādins held deliberations for several days on the question as to whether to omit a day or not, and it was but natural that it so happened. It can not, however, be clearly understood as to how many days used to be left out during a year ; still the idea that a lunar year consisting of 12 lunar months was shorter than 360 days was no doubt prominent in it. In short it may be stated that the civil, the lunar and the solar years were in vogue in the Vedic age.

THE AYANAS

Let us now consider the *ayanas*. *Ayanas* are two — the *Uttarayaṇa* and the *Dakṣiṇāyana*. There appear to be two views regarding the period of time to be indicated by them and the sun's position at those times. The authors of Siddhāntic Astronomy are, however, unequivocal on this point. The two terms have clearly been defined by them, *viz*., the period of the sun's movement from the beginning of Capricornus to that of Cancer is known as *Udagāyana* and that from Cancer to Capricornus as the *Dakṣiṇāyana*. If the sun be observed on any consecutive four or five days during Udagāyana at the time of rising or at any other fixed time, it would every day be found at a point shifted to the north as compared with its position on the preceding day, irrespective of whether the sun is at the north or south of the celestial equator. During Dakṣiṇāyana the sun is found to be moving from north to south. According to some writers Udagāyana in the northern hemisphere is the period from the beginning of *Śiśira* to the end of *Grīṣma*, and according to some others it is from the middle of *Hemanta* to the middle of *Grīṣma*. The above astronomical meaning of Udagāyana has generally been accepted in all modern works, but the word 'ayana' appears to have been carrying a different sense in early days. *Śatapatha Brāhmaṇa* contains the following :—

वसंतो ग्रीष्मो वर्षाः । ते देवा ऋतवः शरद्धेमंतः शिशिरस्ते पितरो......स (सूर्यः) यत्रोदगावर्तते । देवेषु तर्हि भवति......यत्र दक्षिणावर्तते पितृषु तर्हि भवति.

शत. ब्रा. २. १. ३.

The words Udagāyana and Dakṣiṇāyana have not been explicitly used here, but it is simply stated that the sun is said to be entering the region of gods when it turns north and the spring, summer and the rainy seasons

are stated to be the seasons belonging to the gods. It, therefore, appears that the interpretation in vogue was that Udagāyana denoted the period during which the sun kept to the north of equator, and Dakṣiṇāyana, the one during which it kept to the south.

Some astronomical Saṁhitā works appear to use the term 'ayanas' in this very sense, for they speak of the Udagāyana as the day of the gods ; and to the gods residing on the *Mount Meru*, the sun in its northward course is continuously visible for six months, which shows that the term Udagāyana is to be applied to the continuous position of the sun to the north of the equator. The *Bhāgavata* also gives the same meaning.

तस्मादादित्यः षण्मासो दक्षिणेनैति षड़ुत्तरेण

तै. सं. ६. ५. ३.

In the above line of *Taittirīya Saṃhitā* it has been stated that the sun moves towards the south for six months, and towards the north for another six months. An extract from *Nirukta* regarding the progress of the soul after death has been quoted in the succeeding pages (see paragraph on *Niruka infra*) and it refers to the sun's northward and southward motion. A similar description is found in most of the *Upaniṣads*, but it is all in a general sense. With the exception of the above quotation from the *Śatapatha Brāhmaṇa*, nowhere in the Vedas any reference has been found that clearly shows what measure of time was denoted by the word 'ayana'. The words Udagāyana and Uttarāyaṇa occur in the Maitrāyaṇī-Upaniṣad and in the following lines from the *Nārāyaṇa Upaniṣad* (anuvāk 80).

य......उदगयने प्रमीयते देवानामेव महिमानं गत्वादित्यस्य सायुज्यं गच्छत्यथयो दक्षिणे प्रमीयते पितृणामेव महिमानं गत्वा चंद्रमस सायुज्यंसलोकतामाप्नोति.

नारायण उपनि. अनु. ८०.

Excepting these two works, all others have generally used the words Devayāna and Devaloka for Udagāyana, and Pitṛyāna and Pitṛloka for Dakṣināyana. Nothing can definitely be said as to whether these words carried the same meaning as the word '*ayana*' in the *Śatapatha Brāhmaṇa* or whether it was used also in the other sense in some other places, and as to which of the two was more ancient and when the other sense came into vogue. There is, however, no ambiguity about the interpretation of the *ayanas* as given by the astronomical works as quoted above, and this is found in all works on astronomy and is generally accepted at present.

SEASONS

Let us now consider the question of seasons. This has already been partially discussed above.

The names of seasons like *Śarad* and *Hemanta* occur at many places in Ṛk Saṃhitā. The word 'Ṛtu', however, does not occur by itself as frequently in the Ṛk Saṃhitā, as it does in both the schools of Yajurveda and Bahvṛca Brāhmaṇa. The Rigveda Saṃhitā does not on the whole appear to attach much importance to the seasons. The 28th and 29th sections of the 3rd chapter of the 5th aṣṭakā of Ṛk-Saṃhitā give about 50 to 60 sentences

in which prayers to gods like '*Śaṁ na Indrāgnī bhavatāṁ*' meaning 'may gods Indra and Agni bless us' are found but nowhere is found a single sentence to the effect that the year, seasons, months and nakṣatras may bless one. One would expect to find in an equal number of stanzas in the *Yajurveda* at least some stanzas devoted to prayers to seasons.

Number of Seasons

Excepting the Ṛk Saṃhitā all other Vedic works mention six as the number of seasons at various places, and at many of these places the names of all the seasons have been mentioned collectively (*see Tai. Saṃ*. 4. 3. 2 ; 5. 6. 23 ; 7. 5. 14 ; etc. Some of the places have already been pointed out above).

At several places however it is stated that the seasons are five in number : for instance,

पंचशारदीयेन यजेत ।।......पंच वा ऋतवः संवत्सरः

तै. ब्रा. २. ७. १०.

"Sacrifice should be performed in five Śāradiyas (*i.e.* seasons).......... because a year has 5 seasons". Since the year was supposed to have five seasons, it seems that Hemanta and Śiśira formed one season. The following line may be seen for this purpose.

द्वादशमासाः पंचर्तवो हेमंतशिशिरयोः समासेन.

ऐ. ब्रा. १. १.

"Twelve months comprise five seasons of which Hemanta and Śiśira together form one".

Even from the Taittirīya Saṁhitā, Taittirīya Brāhmaṇa and Śatapatha Brāhmaṇa it is seen that when the year was supposed to have five seasons, Hemanta and Śiśira were taken together to form one. Even Mādhavācārya observes (under 'determination of seasons' in Kāla Mādhava) that in such cases the season of Śiśira should be included in Hemanta and cites authorities in support of his argument. In some rare places (*see* Śatapatha Brāhmaṇa 3. 4. 4. 17.) the seasons are said to be three in number.

The First Season

In the Vedas, wherever all the six seasons are mentioned collectively, they are found to begin with Spring. In addition there are explicit statements that Spring is the chief season, *e.g.*

मुखं वा एतदृतूनां ।। यद्वसंतः ।।

तै. ब्रा. १. १. २. ६, ७.

"Spring is the mouth of the seasons."

तस्य ते (संवत्सरस्य) वसंतः शिरः ।। ग्रीष्मो दक्षिणः पक्षः ।। वर्षाः
पुच्छं ।। शरदुत्तरः पक्षः ।। हेमंतो मध्यं ।।

तै. ब्रा. ३. १०. ४. १.

"The spring is the head (of the year) ; the summer is the right wing ; the monsoon forms the tail ; autumn the left wing, and winter the central part."

Similar statements are found at two more places. Here Hemanta is stated to be the middle of the year, and the rainy season its tail.

If the year be compared to a bird, the following chart would correctly represent the position stated above ;

	(Mouth) *Spring*	
(Left wing) *Autumn*	(Belly) *Winter*	(Right wing) *Summer*
	(Tail) *Monsoon*	

Commencement of Seasons

उभयतोमुखमृतुपात्रं भवति कोहि तद्वेद यद्दतूनां मुखं

तै. सं ६. ५. ३.

"Two faced is the vessel of seasons ; who knows which one is the mouth of the seasons ?"

This remark seems to suggest that none can know when a particular season commences. And that is correct. The seasons depend upon the sun's position. If in a certain year a solar month begins, say, simultaneously with a lunar month, it would in the following year commence from the 12th day of the light half and in the subsequent year from the 8th day of the dark half. Therefore, the commencement of a season with respect to the tithi is irregular. Not only this, but it is somewhat irregular with respect to the sidereal solar month also. At present rains start within 4 or 5 days of either ahead or after the beginning of the nirayaṇa Mṛga nakṣatra. The commencing day of a season varies from place to place also ; it is, of course, obvious that the variation would be about five to ten days ; still it was but natural for the ancients to express their thoughts as in the above quotation.

It would be very difficult to obtain an accurate knowledge of the transition moments of two half-months or those of the seasons in the absence of an accurate knowledge of the motions of the luminaries and of the means of measuring time. The following myth will show how difficult it was for the primitive man to note the ending moments of the full moon and the new moon as also the ending of one season and the beginning of the next.

प्रजापतेर्ह वै प्रजाः ससृजानस्य पर्वाणि विसस्रंसुः स वै संवत्सर एव प्रजापतिस्तस्यैतानि पर्वाण्यहोरात्रयोः संधी पौर्णमासी चामावास्या चतुर्मुखानि ॥ ३५ ॥ स विस्रस्तैः पर्वभिः ॥ न शशाकसंहातुं तमेतैर्हविर्यज्ञैर्देवा अभिषज्यन्नग्निहोत्रेणैवाहोरात्रयोः संधी तत्पर्वाभिषज्यंस्तत्समदधुः पौर्णमासेन चैवामावास्येन च पौर्णमासीं चामावास्यां च तत्पर्वाभिषज्यंस्तत्समदधुश्चातुर्मास्यैरेवर्तुमुखानि तत्पर्वाभिषज्यंस्तत्समदधुः ॥ ३६ ॥

शत. ब्रा. १. ६. ३.

"After mankind was created by Prajāpati, his *parvas* (knuckles) became loose. The saṁvatsara (year) itself represented the Prajāpati. The two 'points' of day and night *i.e.* twilight, the full moon and the new moon, and the commencement of seasons—these are his parvas. The gods diagonised the disorder. They cured the 'joints' of day and night and set them in their correct places by maintenance of *agnihotras* (sacred fires). The full and the new moons were correctly adjusted by the *Paurṇamāseṣṭi* and *Darśeṣti* and the 'joints' of the seasons were set right by means of the *'Cāturmāsyayajña'* (*i.e.* four monthly sacrifices)".

This story points to some kind of the association of the knowledge of time with the sacrificial system.

THE MONTHS

Let us now consider the question of the month. It has already been dealt with at some length in the course of the discussion under the heading 'The Year'. Madhu and other names of months have already appeared in the foregoing discussion. In addition to this, some more names are found in Taittirīya Brāhmaṇa and they are now being given in the following quotations which include some different names of seasons and half-months also :—

अथ यदाह ॥ पवित्रन् पवयिष्यन्त्सहस्वान्त्सहीयानरुणोरुणरजा इति ॥ एष एव तत् ॥ एष ह्येव तेर्धमासाः ॥ एष मासाः ॥ अथ यदाह ॥ अग्निष्टोम उक्थ्योग्निर्ऋतुः प्रजापतिः संवत्सर इति ॥ एष एव तत् ॥ एषह्येव ते यज्ञक्रतवः ॥ एष ऋतवः ॥ एष संवत्सरः ॥

तै. ब्रा. ३. १०. ६.

The half-months referred to above are given in the following list. These are the names of the 24 half-months occurring in one year :—

पवित्रं पवयिष्यन् पूतो मेध्यः ॥ यशो यशस्वानायुरमृतः ॥
जीवो जीविष्यन्त्स्वर्गो लोकः ॥ सहस्वान् सहीयानोजस्वान् सहमानः ॥
जयन्नभिजयन्त्सुद्रविणो द्रविणोदाः ॥
आर्द्रपवित्रो हरिकेशो मोदः प्रमोदः ॥

तै. ब्रा. ३. १०. १.

These are the names of 24 half-months occurring in a year.

Following is the list of names of months.

अरुणोरुणरजाः पुंडरीको विश्वजिदभिजित ॥
आर्द्रः पिन्वमानोन्नवान् रसवानिरावान् ॥
सर्वौषधः संभरो महस्वान् ॥

तै. ब्रा. ३. १०. १.

It contains 13 names, apparently including that of the intercalary month.

अग्निर्ऋतुः सूर्य ऋतुश्चंद्रमा ऋतुः ॥

तै. ब्रा. ३. १०. १.

This appears to be the list of six seasons. It may possibly be interpreted as the three seasons (of the year) *viz.*, Agni (Fire), Sūrya (The Sun) and Candramā (The Moon).

At the end, the 'saṁvatsara' (year) is declared to be representing the Prajāpati in the following :—

प्रजापतिः संवत्सरो महान्कः

तै. ब्रा. ३. १०. १.

Names of Months

(Madhvādi and Caitrādi systems)

It can clearly be seen that the Madhvādi and Aruṇādi systems of names have a close association with the seasons and not with the nakṣatras. These names are not found in the Rigveda Saṃhitā, But the Brāhamaṇic works of the Aitareya, the Taittirīya and the Vājasaneyi Saṃhitās appear to attach considerable importance to Madhu and other names. In these works, however, one does not come across terms like Caitrī etc., involving nakṣatras and having for their derivations such definitions as these :

(i) That the full moon day on which the moon becomes full near the star Citrā (Spica) is to be termed Caitrī-Pūrṇimā, and

(ii) That lunar month in which the Caitrī-Pūrṇimā occurs, is termed Caitra.

To come to know that the moon always becomes full near particular nakṣatras is the first stage ; that introduction of names like Caitrī, Vaiśākhī, etc. for these full-moon nights after a lapse of time is the second stage and the third stage is the establishment of a complete nomenclature to start with, as being governed by the rule " *Sāsmin Paurṇamasīti*" (Pāṇini 4-2-21) meaning " it is so called, because the full moon night of that name falls in that month ". The names of nakṣatras are found in all the above mentioned Vedas at many places ; but it is only at two places that the moon has been explicitly mentioned as becoming full near a star. The passages are quoted below.

These occur in the following stanzas from Taittirīya Saṃhitā, which also contains references to time-units in the discussion of the problem, regarding the time when one should consecrate oneself for the annual sacrifice known as '*Gavā-mayana*' and that is why it is quoted here in full.

संवत्सराय दीक्षिष्यमाणा एकाष्टकायां दीक्षेरन्नेषा वै संवत्सरस्य पत्नी यदेकाष्टकैतस्यां वा एष एतांरात्रिं वसति साक्षादेव संवत्सरमारभ्य दीक्षंत आर्तं वा एते संवत्सरस्याभिदीक्षंते य एकाष्टकायां दीक्षंतेऽतनामानावृतू भवतो व्यस्तं वा एते संवत्सरस्याभिदीक्षंते य एकाष्टकायां दीक्षंतेऽतमानावृतू भवतः फल्गुनीपूर्णमासे दीक्षेरन्मुखं वा एतत् ॥ १. ॥ संवत्सरस्य यत्फल्गुनीपूर्णमासो मुखत एव संवत्सरमारभ्य दीक्षंते तस्यैकैव निर्या यत्सांमेध्ये विषूवांत्संपद्यते चित्रापूर्णमासे दीक्षेरन्मुखं वा एतत्संवत्सरस्य यच्चित्रापूर्णमासो मुखत एव संवत्सरमारभ्य दीक्षंते तस्य न काचन निर्या भवति चतुरहे पुरस्तात् पौर्णमास्यै दीक्षेरन् तेषामेकाष्टकायां

ऋय: संपद्यते तेनैकाष्टकां न छंबट् कुर्वंति तेषां ॥ २ ॥ पूर्वपक्षे सुत्या संपद्यते पूर्वपक्षं मासा अभिसंपद्यंते ते पूर्वपक्षे उत्तिष्ठंति तानुत्तिष्ठत ओषधयो वनस्पतयोनूत्तिष्ठंति तान् कल्याणी कीर्तिरनूत्तिष्ठत्यरात्सुरिमे यजमाना इति तदनु सर्वे राध्नुवंति ॥

तै. सं. ७. ४. ८.

"Those who are desirous of performing a 'saṁvatsara' (yearly) sacrifice should consecrate themselves on the *Ekāṣṭakā* tithi. The Ekāṣṭakā is the wife of the saṁvatsara himself. He dwells with her on that night. Hence, such people (as are consecrated on the Ekāṭṣakā Tithi) are taken as consecrated in the very beginning of the year.

Those who become consecrated on the Ekāṣṭakā day get 'consecrated' against the troubles of the year. Their seasons bear the names of last two seasons. Those who consecrate themselves on the Ekāṣṭakā day become consecrated against the 'confusions' of the year. The year becomes disintegrated for them. Their seasons bear the last two names of the list. One should get consecrated on the full moon day of the Phālguna, because Phālguna full moon is the 'mouth' of the year. Hence, (such people) are taken as consecrated from the very beginning of the year. But such people have to accept one 'niryā' (draw back) *viz.* that the 'Viṣuvān' (equinox) occurs in the cloudy season (sānmedhya). Hence, one should consecrate in the Citrā-full-moon day. The Citrā-full-moon day is the 'mouth' of the year. Hence, those (who commence their sacrifice on this day) are said to be consecrated from the 'mouth' of the year. This involves no drawback. One should pass through consecration on the 4th day before the full moon day, thereby, they secure the *kraya i.e.* the purchase of soma juice. Thereby they avoid making the Ekāṣṭakā fruitless. They secure the occasion for extracting the soma juice in the 'former half-month' and secure the proper position of the half-month and the months also. They rise in the former half-month and the herbs and trees grow after them. They (*i.e.* sacrificers) get fame as prosperous persons and consequently all prosper".

This passage also occurs in the *Tāṇḍya Brāhmaṇa* (5. 9) of Sāma Veda. It, however, contains a few different words and one or two different sentences*.

The words 'Phalgunī Pūrṇamāsa' and 'Citrā Pūrnamāsa' occur in the above passage. They only mean the full moon nights associated with the stars Phalgunī and Citrā. It should be noted that neither the words Phālguna and Caitra nor the terms Phālgunī and Caitrī occur therein.

न पूर्वयो:फल्गुन्योरग्निमादधीत ॥ एषा वैजघन्या रात्रिः संवत्सरस्य ॥ यत् पर्वेफल्गुनी ॥ पृष्टित एव संवत्सरस्याग्निमाधाय ॥ पापीयान् भवति ॥ उत्तरयोरादधीत ॥ एषा वै प्रथमा रात्रिः संवत्सरस्य ॥ यदुत्तरेफल्गुनी ॥ मुखत एव संवत्सरस्याग्निमाधाय ॥ वसीयान् भवति ॥

तै. ब्रा. १. १. २. ८.

*The *Tāṇḍya Brāhmaṇa* mentions one more draw back of the Ekāṣṭkā in the words "*aponabhinandantobhyavayanti*", meaning the sacrificers do not salute water before taking on "*avabhritha*" bath and the word "*saṁmedha*", which has been used for *sānmedhya*, renders it as "on a cloudy day".

"Fire should not be kindled on the Pūrva Phalgunī nights ; (since) Pūrva Phalgunī is the last night of the year. It should be kindled on the Uttara Phalgunī. This is the first night of the year."

Although the word 'full moon night' is not explicitly mentioned here, still the full moon night when the Pūrva Phalgunī stars come together with the full moon, appears to be implied in it. That the moon becomes full near the Phalgunī nakṣatra is the idea suggested by these words. However, not only the word Phālguna does not occur in it, but even the word "*Phalgunī-purṇamāsa*" does not occur in it as it does in the lines quoted above from the Saṁhitā.

The above lines show that the phenomenon of the moon becoming full near certain stars had been noticed in the times of Taittirīya Saṁhitā and Brāhmaṇa. Still it must be remembered that the names Caitra etc., had definitely not come into vogue in those times.

एषा ह संवत्सरस्य प्रथमा रात्रिर्या फाल्गुनी पूर्णमासी ॥

शतपथब्राह्मण ६. २. २. १८.

फाल्गुन्यां पौर्णमास्यां चातुर्मास्यानि प्रयुंजीत । मुखं वा एतत्संवत्सरस्य यत्फाल्गुनी पौर्णमासी ॥

गोपथब्राह्मण. ६. १९.

The words "*Phālgunī Purṇamāsī*" occur in this. Even the *Sāṅkhyāyana Brāhmaṇa* (which the author has not seen) is said to contain the following line:—

या वैषा फाल्गुनी पौर्णमासी संवत्सरस्य प्रथमा रात्रिः ॥

Any way, the word 'Phālgunī' occurring in all these quotations only means "associated with the Phalgunī star". The words 'Phālgunī Pūrṇamāsī' occurring in *Śatapatha Brāhmaṇa* (2-6-3) has been defined by Sāyanācārya as "that full moon night which becomes associated with the two Phalgunī asterisms is known as the Phalgunī". The *Sāmavidhāna Brāhmaṇa* (2.4) contains the line,

या रौहिणी वा पौषी वा पौर्णमासी.

सामवि. ब्रा. २. ४.

In this 'Rauhiṇī' simply means "associated with Rohiṇī star", it has nothing to do with the 'Rauhiṇa' month. Similarly, the Pauṣī, the Phalgunī, etc., stand for those full moon nights which are associated with the stars of corresponding names. In short, it can be said that only the terms 'Phālgunī' etc., had come into vogue at the time when Brāhmaṇa works were compiled. Nowhere in the Saṁhitā and Brāhmaṇa do the words Phālguna, Caitra, etc., occur in the sense of names of months, and this shows that these terms were not then in vogue. Much time must necessarily have elapsed before the term Phālguna, Caitra etc., came into vogue, even when the terms Phalgunī, etc., had gained currency. This point can be easily understood if one considers as to how long a time has to elapse before a scientific theory becomes an established truth.

In short, the terms Caitra, etc., were not in vogue in the Saṁhitā and Brāhmaṇa period. Thus it can be proved from the historical point of view that these terms came into use after a very long period of time after the terms Madhu, etc., became current.

It will now be shown that even the Nature works in the same order of development.

In the beginning, man must have been guided by the moon for counting the months ; and the cluster of stars situated in the path through which the sun and the moon are generally seen to move, must have received the names of 27 stars. But the position of the stars remains practically constant in relation to the ecliptic and, therefore, even after the names Madhu, etc., had come into vogue and the 27 nakṣatras had received special names, a considerable period of time must have elapsed ; firstly, before it was minutely observed that the moon moves through particular groups of stars and that it becomes full near some of them and secondly, before the terms (Caitrī Paurṇimā, etc.,) came into vogue on the basis of that observation and thirdly, the terms Caitra etc., finally arose therefrom and became current as the names of months.

For instance, the star Aldebaran (Rohiṇī) lies about 5½° to the south of the ecliptic and must have remained in that position for thousands of years, but the moon does not move exactly on the ecliptic. It attains a position with maximum latitude of 5° to 5½° north or south of the ecliptic. Its path cuts the ecliptic. Had the points of intersection, that is, the moon's nodes (Rāhu and Ketu) been stationary, its position relative to the stars, would have remained unchanged ; but the nodes have got motion. They make a complete revolution in about 18½ years. It is on account of this that the moon and the star Rohiṇī at times come together in the course of 18½ years. Sometimes the moon occults the star while sometimes it is seen to be at a distance of about 11° of latitude from it. The phenomenon of the moon sometimes occulting a star and sometimes remaining away from it at a latitude of about 11°, is no mean source of confusion in one's attempt at detecting the rule about the occurrence of the full moon near the stars. It is in fact much more confusing and to add to this, there is another kind of minor confusion. For instance, during the period from September 1884 to March 1888, the moon regularly used to occult the star Rohiṇī (Aldebaran), once in the course of every revolution and this phenomenon was observable at one place or the other on the earth. But it was not that every such occultation of Rohiṇī occurring during the revolutions of the moon would be seen at a given place on the earth. This interesting phenomenon could be seen in our province only on 3 or 4 occasions. On other occasions this phenomenon used to take place sometimes by day or sometimes when the moon was below the horizon. On some occasions, the moon used to appear only at a very short distance from Rohiṇī. Moreover, this position is not necessarily true in the case of all stars. In other words, the moon does not necessarily occupy a distance* of +5° maximum latitude from each star in each revolution of the node ; for it sometimes comes very near to some stars and goes away from others ; it moves via north in the case of some, and passes in a southerly direction in the case of others. Other kinds of confusion involved in perceiving this phenomenon of the full moon near the stars and formulating a rule about it are also worth noting.

For instance, if the moon becomes full near a particular star in the first month, it will become full again near the next second or third star in the

*This point cannot be fully discussed here. One can understand this by noting the moments of its conjunctions with the stars during any period of 5 to 7 years, as given in the tables on the lunar conjunctions with stars in the Sāyana almanacs.

next month. The rule about the full moon's proximity with certain stars would be easily discovered, if after the completion of 12 lunar months the moon becomes full near the same star in the second round of 12 months as in the first.

But it so happens that if it is found to be full near, say, Aśvinī, in the first month of the first round, it would appear to have become full near Revatī in the first lunar month of the second round. It is also not true that the moon becomes full only near those 12 asterisms to which Caitra and other lunar months owe their origin. As a matter of fact, it becomes full near each of the 27 asterisms in some month or the other. There is still another difficulty ; there are only four out of the 27 stars which do not fade but remain visible even when the full moon is in close proximity with them, and they are Maghā, Jyeṣṭhā, Citrā and Rohiṇī. Some of the rest become invisible when the moon approaches them within a distance of 7° to 8° and there are still others which fade away in the moon's lustre when it is still further away. In short, it is obvious that long time must have elapsed before the rule about the moon's becoming full near particular stars could be established after the asterisms received their names. The next stage was the application of the names Caitrī, Vaiśākhī, etc., to the full moons, and the stage next to this was the naming of lunar months after the stars.

In short, it is proved, from the natural order of progress and from the historical point of view, that the terms Caitra etc. came into vogue when considerable time had elapsed after the introduction of names like Madhu, etc.

The Solar Months

References to the civil and lunar months are definitely found in the Vedas ; but an explicit mention of solar months is not found anywhere in them. The solar month is the time which the sun takes to cross each of the 12 equal divisions of the '*bhacakra*' (zodiac). Meṣa and other names of Rāśis are not found in the Vedas ; but that is immaterial. But even a corresponding set of names for the 12 equal divisions of the '*bhacakra*' are also not found anywhere. Now, it cannot be said for certain that Madhu-Mādhava given in the Vedas as names of months were not the names of solar months for, while their connotation indicates some relationship with the seasons, that is indirectly with the sun, they are also used as synonyms for the seasons (*see* page 18). We do not, however, find any statement that they ended on days other than the full moon or the new moon days. On the other hand, we find it definitely mentioned that months end either on the full moon day or the new moon day. Hence, these appear to be the names of lunar months or in other words of the months which end on full moon or new moon days. The year, however, was undoubtedly solar, hence why should it be considered improbable that solar months different in measure from lunar months were also in vogue ? In all probability, they were in current use and there are grounds to believe that just as Madhu and other names were applied to lunar months they were equally applicable to solar months also.

The Amānta and Pūrṇimānta Months

Let us now see if the months were Pūrṇimānta or Amānta. That month which ends with Amāvasyā or the new moon is called Amānta and the one which ends in Pūrṇimā or the full moon is called Pūrṇimānta. Both these

modes of reckoning are found in the Vedas. That (night) on which the Māsa (month) becomes *pūrṇa* (full or complete) is *Paurṇamāsī*. Hence, the very word Paurṇamāsī indicates the Pūrṇimānta reckoning.

बर्हिषा पूर्णमासे व्रतमुपैति वत्सैरमावास्यायां ॥

तै. सं. १. ६. ७.

"Religious vow is commenced with a sacrifice on the full moon day and with calves on the new moon day".

In this quotation the word coupled with 'Amāvasyā' is Pūrṇamāsa, which shows that the month used to become full on the Paurṇamāsī day.

The following quotation from a stanza in "*Utsargīṇāmayana*" shows that the months* ended both on Amāvasyā and Pūrṇimā :—

अमावास्यया मासान्संपाद्याहरुत्सृजंति अमावास्यया हि मासान् संपश्यंति पौर्णमास्या मासान्संपाद्याहरुत्सृजंति पौर्णमास्या हि मासान्संपश्यंति ॥

तै. सं. ७. ५. ६. १.

The following lines immediately following the above stanza specially appear to favour the Pūrṇimānta system :—

यो वै पूर्ण आसिंचति परा स सिंचति यः पूर्णादुदचति प्राणमस्मिन्त्सदधाति यत्पौर्णमास्या मासांत्संपाद्याहरुत्सृजंति संवत्सरायैव तत्प्राणं दधति तदनु सत्रिणः प्राणंति यदहर्नोत्सृजयुर्यथा दृतिरुपनद्धो विपतत्येवं संवत्सरो विपतेदार्तिमार्छेयुर्यत्पौर्णमास्या मासान् संपाद्याहरुत्सृजंति संवत्सरायैव तदुदानं दधति तदनु सत्रिण उदनंति नार्ति मार्छंति पूर्णमासे वै देवानांसुतो यत्पौर्णमास्या मासान्त्संपाद्याहरुत्सृजंति देवानामेव तद्यज्ञेन यज्ञं प्रत्यवरोहन्ति ॥

तै. सं. ७. ५. ६.

In the chapter on 'Universe' in the *Atharvaśruti*, the description of the 'Creation of Saṁvatsara' is followed by these lines referring to the month and the half-month :—

मासो वै प्रजापतिः ॥ तस्य कृष्णपक्ष एव रविः शुक्लः प्राणः ॥

"The month is verily the Prajāpati ; its dark half is the Sun and the light half the Life (soul)."

In this, the dark half is mentioned first ; this shows that the Pūrṇimānta system was in vogue. But the Taittirīya Brāhmaṇa gives the list of names of days in the two halves of a month (*see* page 43); the list gives the names of days in the light half first and those in the dark half afterwards; this leads one to believe that even the amānta system was in use.

THE PŪRVA AND THE APARA HALF

If the Pūrṇimānta system be adopted, the dark half of the month comes first and the light half afterwards, and hence, the term 'pūrva' should have

*The *Kālamādhava*, after considering the doubts raised against these quotations, has given the verdict that these lines describe both the pūrṇimānta and the amānta systems.

been applied to the dark half and 'apara' to the light one ; but it is not so. The 'pūrva-apara' terms are applied respectively to the light and the dark half.

पूर्वपक्षं देवान्वसृज्यंत । अपरपक्षमन्वसुराः ॥ ततो देवा अभवन् । परासुराः ॥

तै. ब्रा. २. २. ३. १.

"Gods were born in the 'pūrva-pakṣa' and the demons (asuras) in the 'apara-pakṣa' that is why the gods won and demons were defeated."

पूर्वपक्षाश्चितयः ॥ अपरपक्षाः पुरीषं ॥

तै. ब्रा. ३. १०. ४ .१.

"The pūrva-pakṣa is the girdle and the apara-pakṣa is the dirt".

Although the terms light and dark are not explicitly mentioned, the fact that 'Śukla' indicates something auspicious and 'Kṛṣṇa' something inauspicious, one may presume that the term 'Pūrvapakṣa' stood for 'śukla' and 'apara' for 'Kṛṣṇa'. The names of the 15 days of each of the 'Pūrva' and 'Apara' halves are given later on, and the terms 'Pūrva' and 'Apara' have been used in the sense of 'Śukla' and 'Kṛṣṇa' in them. In the '*Nirukta*' (11·6) it is said in the *mantra* concerning the moon,

नवो नवो भवति जायमान इति पूर्वपक्षादिममभिप्रेत्याग्हां केतुरुषसामेन्यग्रमि
त्यपरपक्षांतमभिप्रेत्य......॥

The word 'Pūrvapakṣa' has clearly been used in the sense of 'Śukla-pakṣa' and the 'Apara-pakṣa' in the sense of 'Kṛṣṇa-pakṣa'. The words 'pūrvāpara' are found used in this very sense in the post-Vedic works.

THE DAY

Let us now consider the civil day, the solar day and the lunar day (*i.e. tithi*). The solar month does not explicitly occur in the Vedas and hence, it is clear that the solar day also was not in vogue. One expects the civil day to be mentioned in the Vedas and so it is. It is very convenient for civil purposes. Quotations have already been given showing that the sacrifices were performed with respect to civil days.

Names of Days

The Taittirīya Brāhmaṇa gives different names for the days and nights in the light and dark halves of the month. They are :—

संज्ञानं विज्ञानं दर्शा दृष्टेति ॥ एतावनुवाकौ पूर्वपक्षस्याहोरात्राणां नाम धेयानि ॥
प्रस्तुतं विष्टुतँ सुतासुन्वतांति ॥ एतावनुवाकावपरपक्षस्यहोवात्राणां नामधेयानि ॥

तै. ब्रा. ३. १०. १०. २.

The '*anuvāks*' (stanzas) mentioned here are given in the same Brāhmaṇa in one 'anuvāk' at a different place. They are :—

संज्ञानं विज्ञानं प्रज्ञानं जानदभिजानत् ॥ संकल्पमानं प्रकल्पमानमुपकल्पमानमुपक्लृप्तं क्लृप्तं ॥
श्रेयो वसीय आयत् संभूतं भूतं ॥

तै. ब्रा. ३. १०. १. १.

These are the names of the days (excluding nights) of the 'Pūrvatpakṣa'. They are 15 in number mentioned in groups of five in each line.

दर्शा दृष्टा दर्शता विश्वरूपा सुदर्शना ॥ अप्यायमाना प्यायमाना प्याया सूनृतेरा ॥
आपूर्यमाणा पूर्यमाणा पूरयंती पूर्णा पौर्णमासी ॥

तै. ब्रा. ३. १०. १. १.

This is a list of the names of 15 nights of a 'Pūrva-pakṣa' which stands for the light half as is suggested by the word 'Pūrṇamāsī' etc. occurring in it.

प्रस्तुतं विष्टुतँ सँस्तुतं कल्याणं विश्वरूपं ॥ शुक्रममृतं तेजस्वि तेजः समृद्धं ॥
अरुणं भानुमन् मरीचिमदभितपत् तपस्वत् ॥

तै. ब्रा. ३. १०. १. २.

These are the names of the 15 days in the 'Apara-pakṣa' or the dark half.

सुता सुन्वती प्रसुता सूयमानाऽभिषूयमाणा ॥ पीती प्रपा संपा तृप्तिस्तर्पयंती ॥
कांता काम्या कामजाताऽयुष्मती कामदुघा ॥

तै. ब्रा. ३. १०. १. २. ३.

These are the names of the 15 nights in the dark half. The names of days given in the list are used in the neuter gender while those of nights are in the feminine. It appears that because the word '*aha*' meaning "a day" has the neuter gender, the names of days are in neuter gender and because the word '*rātri*' (night) is in the feminine, the names of nights are also in the feminine gender.

The above line gives "Kāmadughā" and not Amāvasyā, as the name of the last night of the dark half. The last night of the light half is however indicated by the word "Paurṇamāsī" itself.

The above lines and the references at other places show that Paurṇamāsī and Amāvasyā are the qualifying adjuncts of 'night' and not of 'tithi'. The words amāvasyā and paurṇamāsī occur quite frequently in the Taittirīya Saṁhitā and the word 'tithi' does not occur at all. Hence, the two words cannot possibly indicate a 'tithi'.

TITHI

Nowhere in the Vedic literature the author came across the word 'tithi' in the sense of the 30th part of the lunar month or the time required by the moon to gain 12° of longitude on the sun. Even though the month is lunar, its 30th part will be shorter than the civil day, because its length is about 29½ civil days. Hence, the mean length of the tithi is shorter than a civil day and there is no easy and natural means to measure it, and on account of this we do not get in the Vedas either the true or the mean tithi in its modern sense.

The word tithi occurs in the *Bahvrica Brāhmaṇa* at some places and the definition of the tithi as given at one place is,

यां पर्यस्तमियादभ्युदियादिति सा तिथिः ॥

ऐ. ब्रा. ३२. १०.

"Tithi is that period of time during which the moon sets and rises again".

The interval between two consecutive moonrises is longer than a civil day by about a "*muhūrta*" (*i.e.*, 48 minutes). The sun rises 29 or 30 times during a lunar month and the moon rises 28 or 29 times. Hence, 30 tithis according

to the above definition will never occur in a lunar month. We do not get this definition in other Vedas or post-Vedic literature. This shows that this definition was not much in vogue. It may be that the true import of the definition was different. In any case, the 'tithi' in the astronomical meaning and 'pratipad' and other tithis are found nowhere in the Vedas. But Pūrṇimā and Amāvasyā are denoted by the word "*Pañcadaśī*" meaning 15th.

चंद्रमा वै पंचदशः ।। एष हि पंचदश्यामपक्षीयते ।। पंचदश्यामापूर्यते ।।

तै. ब्रा. १. ५. १०.

"The moon wanes on the Pañcadaśī night. (She) becomes full on the Pañcadaśī night".

Since the term Pañcadaśī has occurred in the sense of 'fifteenth', other terms, such as Pratipad, Dvitiyā, etc., must have been in use to denote the first night, the second night etc. In the beginning, these must have been used to denote the nights and afterwards the tithis. The terms Kṛṣṇa Caturdaśī, Kṛṣṇa Pañcamī, Śukla Caturdasī, have occurred in the *Sāma Vidhāna Brāhmaṇa* (*see* 2, 6 ; 2, 8; 3, 3).

Aṣṭakā

We come across the term 'aṣṭakā' somewhat similar to amāvasyā and pūrṇimā. The following line may be seen :—

द्वादश पौर्णमास्यः ।। द्वादशाष्टकाः ।। द्वादशामावास्याः ।।

तै. ब्रा. १. ५. १२.

"The full moon nights are twelve, the aṣṭakās are twelve, the new moon nights are twelve".

A sentence similar in meaning is found even in the *Śatapatha Brāhmaṇa* (6.4.2.10). From this it appears that just as 12 full moons or 12 new moons occur in one year's time, so also 12 aṣṭakās occur in one year. The number occurring during the year is said to be 12 and not 24. From this it appears that 'aṣṭakā' might be the term applied to the 8th night, either of the light half or of the dark half of the month. The word aṣṭakā comes after the word Pūrṇimā in the above line. It occurs similarly in the following line :—

पौर्णमास्यष्टकामावास्या ।।

तै. ब्रा. ३. ११. १. १६.

From this it seems that the 8th night in the dark half of the month must have been termed 'aṣṭakā'. This has been explicitly stated in the *Āsvalāyana* and other Sūtras :—

द्वादश पौर्णमास्यो द्वादशैकाष्टका द्वादशामावास्याः ।।

तांड्य ब्रा. १०. ३. ११.

In this, the 8th night of the dark half is termed 'ekāṣṭakā'. The Āpastambha Sūtra applies the term 'ekāṣṭakā' to the 8th night after the Māghī Pūrṇimā.

Vyaṣṭakā and Udṛṣṭa

पौर्णमास्यां पूर्वमहर्भवति ।। व्यष्टकायामुत्तरं ।।......

अमावास्यायां पूर्वमहर्भवति ।। उदृष्ट उत्तरं ।।

तै. ब्रा. १. ८. १० २.

These sentences occur also in the *Tāṇḍya Brāhmaṇa* (18.11.8). According to these lines 'Vyaṣṭakā' was the 1st night of the dark half of the month and Udṛṣṭa, the 1st night of the light half.

THE MOON'S PHASES

In the Vedas we come across the belief that the phases of the moon increase and decrease because they are drunk by the gods.

यत्वा देव प्रपिबंति तत आप्यायसे पुनः ॥ वायुः सोमस्य रक्षिता समानां मास आकृतिः ।

ऋ. सं. १०. ८५. ५.

"Oh Moon ! The gods drink you, but later on you become bright again. The wind is the protector of the moon. Thou art the maker of *samas* (*i.e.* years), and of the months."

This 'richā' is construed in the Nirukta, as applicable to the 'soma' plant as well as the moon.

यमादित्या अंशुमाप्याययंति यमक्षितमक्षितयः पिबंति ।

तै. सं. २. ४. १४.

"The suns make her bright, and when she is full, they drink (devour) her."

The word sun is used here in the plural. It must have been so used to denote the 12 suns of the year. This shows that in the beginning it was perhaps the belief that it was the sun who brings about the increase or decrease of the phases. Afterwards when the word '*āditya*' began to denote 'gods', the belief that gods devour the moon must have arisen.

MOON'S LIGHT

The following line states in clear terms that the moon receives light from the sun :—

सूर्यरश्मिश्चंद्रमा गंधर्वः ॥

तै. सं. ३. ४. ७. १.

The moon is here spoken of as 'Sūrya-raśmi', that is the one who receives rays of light from the sun.

WHERE DOES THE MOON DWELL ON AMĀVASYĀ DAY

The following lines express the belief that the moon is seen nowhere in the sky on the new-moon night, because she comes to earth and enters the medicinal herbs.

सोमावास्यायां रात्रिमेतया षोडश्या कलया सर्वमिदं प्राणभृदनु प्रविश्य ततः प्रातर्जायते ॥

बृहदा. शत. षा. १४. ४. ३. २२.

एष वै सोमो राजा देवानामन्नं यच्चंद्रमाः स यत्रैष एतां रात्रिं न पुरस्तान्न पश्चाद्दृशे तर्दिमं लोकमागच्छति स इहैवापश्चौषधीश्च प्रविशति स वै देवानां वस्वन्नं ह्येषां तद्यदेष एतां रात्रिमिहामावसति तस्मादमावास्या नाम ॥

शत. ब्रा. १. ६. ४. ५.

The following line, however, states that the sun and the moon dwell together on the amāvasyā day :—

चंद्रमा आमावास्यामादित्यमनुप्रविशति......आदित्याद्वै चंद्रमा जायते ।

ऐ. ब्रा. ४०. ५.

"The moon enters the sun on the new moon day. The moon is (again) born *of* the sun".

The statement *viz.* "the moon is born of the sun" refers to moon's re-appearance in the evening of the 1st day of the light half.

DARŚA, PARVA, ANUMATI, etc.

The term '*darśa*'* is applied to amāvasyā and the term '*parva*' is applied to 'amāvasyā' and 'pūrṇimā' both. Similarly the terms '*anumati*' and '*rākā*' are applied to full moon nights and '*sinīvālī*' and '*kuhū*' to new moon nights. The terms 'rākā' and 'sinīvālī' occur in Ṛk Saṁhitā (2.32). They might be denoting some deities also.

या पूर्वा पौर्णमासी सानुमतिर्योत्तरा सा राका या पूर्वामावास्या सा सिनीवाली योत्तरासा कुहूः

ऐ. ब्रा. ३२. १०. गो. ब्रा. ६. १०.

"The former (part of) full moon night is called 'Anumati', the latter is called 'Rākā', the former (part of) new moon night is 'Sinīvālī' and the latter Kuhū."

This line appears in the *Kaṭha* branch of the Vedas also. The *Nirukta* observes :—

सिनीवाली कुहूरिति देवपन् न्याविति नैरुक्ता अमावास्येति याज्ञिकाः ।।

निरु. ११. ३१.

"According to Niruktas (etymologists) Sinīvālī and Kuhū are the wives of gods ; but according to the sacrificers they are simply new moon nights."

MOTIONS OF THE SUN AND THE MOON

The amāvasyā's and pūrṇimā's occupy an important place in the Vedic literature in respect of sacrifices. It was the sacrifices performed on the new moon and the full moon days which were, beyond doubt, responsible for such researches as were made in the Vedic age, as those relating to the motions of the luminaries but not described in the Vedic literature for want of suitable occasions—researches which gradually developed into the Vedāṅga Jyotiṣa. The Vedic conjunctions like '*Sandhau yajeta*' or *sandhimabhito yajeta* (i.e. one should perform a sacrifice at or near the 'junction' of a parva) suggest that attempts must have been made to find out when the 'parva-sandhi' occurred and they must have attained some knowledge about it.

*The Matsya and Vāyu Purāṇas speak of "darśa" as follows :— "*Aśritya tāmamāvāsyām paśyatah susamāgatau. Anyonyam candrasāryau tau yadā taddarśa ucyate*" meaning when the Sun and the Moon meet and stay together on the Amāvasyā day and keep gazing at each other, that moment is termed '*darśa*'. This shows that the phenomenon of the moon and the sun coming together was well known to Purāṇas also.

DAYS OF THE WEEK

The names of the seven days of the week are nowhere found in the Vedas. The general term '*vāsara*' meaning 'a day' occurs at two places in the Ṛk Saṁhitā :

आदित्प्रत्नस्य रेतसो ज्योतिष्पश्यंति वासरं ॥ परो यदिध्यते दिवा ॥

ऋ. सं. ८. ६. ३०.

"When god Indra shines in the heaven in the form of the sun, all people observe throughout the day the lustre of Indra in the form of the sun, who possesses an inexhaustible stock of water".

Sāyanācārya has translated the word 'vāsara' as the 'day'; he has also construed it as an adjective qualifying 'jyotiḥ' and rendered it in two ways as (i) *nivāsakaṁ* (dwelling) and (ii) *nivāsasya hetubhūtaṁ* (becoming a cause for dwelling).

THE LENGTH OF THE DAY

The idea that the sun increases the length of the day, or in other words makes the length of the day variable, occurs in the following lines :—

सोमराजन् प्रण आयूंषि तारीरहानीव सूर्यो वासराणि ॥

ऋ. सं. ८. ४८. ७.

"Oh Somarāja! Increase the length of our lives just as the sun increases the length of days, which are vāsara (dwellings of the world)."

The word 'vāsara' occurring here is not used to denote a day.

THE EQUINOCTIAL DAY

One finds in the Vedas a good many references to the equinox. A passage already quoted (Page 28) from Taittirīya Saṁhitā relating to the annual sacrifice refers to the equinoxes. Other references to the equinoxes are given here, since these would be found useful in the study of the question regarding commencement of the year.

Here is a quaint description :—

एकविंशमेतदहरुपयंति विषुवंतं मध्ये संवत्सरस्यैतेन वै देवा एकविंशेनादित्यं स्वर्गाय लोकायोदयच्छंत्स एष इत एकविंशस्तस्य दशावस्तादहानि दिवाकीर्त्यस्य भवंति दशं परस्तान्मध्य एष एकविंश उभयतो विराजि प्रतिष्ठितस्तस्मादेषोंतरेमां लोकान्यन् न व्यथते तस्य वै देवा आदित्यस्य स्वर्गाल्लोकादवपातादबिभयुस्तं त्रिभिः स्वर्गैर्लोकैरव स्तात्प्रत्युत्तभ्नुवन् स्तोमा वै त्रयः स्वर्गा लोकास्तस्य पराचोतिपातादबिभयुस्तं त्रिभिः स्वर्गैर्लोकैः परस्तात्प्रत्यस्तभ्नुवंस्तोमा वै त्रयः स्वर्गा लोकास्तत्र योऽवस्तसप्तदशा भवंति त्रयः परस्तान्मध्य एष एकविंशः

ऐ. ब्रा. १८. १८.

"The 'Ekaviṁśa' (rite) is performed on the equinox day occurring in the middle of the year. This 'Ekaviṁśa' has helped the Āditya to ascend the heaven. This is the same Ekaviṁśa. It takes place ten days before the 'divākīrta' recitations and ten days after, and this Ekaviṁśa occupies the central place. This 'Ekaviṁśa' or Āditya being enclosed on two sides by ten (days) does not find any trouble while moving through this world. The gods apprebended that the sun might fall down. (They) balanced him by lending him a support of three heavens on this side. The three stomas (recited on the three 'Svarasāma' days preceding the equinox) are themselves the three heavens. They (gods) again feared that he (sun) would fall down beyond, they again supported him by placing three more heavens on the other side. These three heavens are the (three) stomas (pertaining to the three days after the equinox). (On the whole) there are seventeen (stomas) on one side and three on the other and in the centre stands the Ekaviṁśa (Twenty-first)."

The Taittirīya Brāhmaṇa also gives a very similar description (*see* 1, 2, 4). In addition to the idea of the equinox occupying the central position, it contains other notions also relating to the sun's high or low position in the sky.

यथा वै पुरुष एवं विषुवांस्तस्य यथा दक्षिणोर्ध एवं पूर्वार्धो विषुवतो यथोत्तरोर्ध एवमुत्तरोर्धो विषुवतस्तस्मादुत्तर इत्याचक्षते प्रबाहुक्सतःशिर एव विषुवान्

ऐ. ब्रा. १८. २२.

"The 'viṣuvān' (equinox) is like the 'puruṣa' ; its former half corresponds to the right half of the 'puruṣa' and the latter half to the left half of the 'puruṣa'. That is why the sacrifice which continues for six months after the equinoctial day is termed 'uttara' (*i.e.* latter). The viṣuvān is like the head of (a sitting man) having left and right arms of equal length ".

The Taittirīya Brāhmaṇa also gives a similar description in the following lines :—

संततिर्वा एते ग्रहाः । यत्परःसामानः ॥ विषुवान् दिवा कीर्त्यं ॥
यथा शालायै पक्षसी ॥ एवँसंवत्सरस्य पक्षसी ॥

तै. ब्रा. १. २. ३.

Here is something about an animal sacrifice. It states that the year, like a house, has two wings (or parts) and viṣuvān is the central portion.

Thus the word visuvān occurs at good many places, where it is said to be in the middle of the annual sacrifice or in the middle of '*parassāman*' days which form part of it.

Nowhere in the Vedas do we find a reference explicitly defining viṣuvān as that day on which the day and night are of equal length. It simply means an interlude occurring in the course of the '*satra*' or '*ṣaḍahas*', no matter whether the 'satra' continued for the whole year or for only a few days (*see* the *Tāṇḍya Brāhmaṇa* 13.4.16 and the commentary thereon by Sāyanācārya). There are only two equinoctial days in the year on which the days and nights are of equal length, and if the annual sacrifice is commenced on one of them, the second equinox will come in the middle of the sacrifice (satra).

PARTS OF THE DAY

Let us now see how the day was divided into parts according to the Vedas. The works on Dharma Śāstra (science of religion) describe systems in which the day, that is the period between sunrise and sunset, is divided into 2,3,4,5 and 15 parts. The two divisions of the day are the '*pūrvāhṇa*' (the former half) and the '*aparāhṇa*' (the latter half) ; the three divisions are 'pūrvāhṇa', 'madhyāhna' (noon) and 'aparāhṇa'. In the fourfold division each part is equal to a 'prahara' (a period of 3 hours), and are successively called 'pūrvāhṇa', 'madhyāhna', 'aparāhṇa' and 'sāyāhna' (evening). The five parts are named 'prātaḥ', 'sangava', 'madhyāhna', 'aparāhṇa' and 'sāyāhna'; and lastly the day is also divided into 15 parts called 'muhūrta'. The first of these systems, which divides the day into two parts is a natural one and it was in vogue in the Vedic times. The following lines describe the system of three fold division.

ऋग्भिः पूर्वाह्णे दिवि देव ईयते ॥ यजुर्वेदे तिष्ठति मध्ये अह्नः ॥

सामवेदेनास्तमये महीयते ॥ वेदैरशून्यस्त्रिभिरेति सूर्यः ॥

तै. ब्रा. ३. १२ ६. १.

पूर्वाह्णो वै देवानां मध्यंदिनो मनुष्याणामपराह्णः पितॄणां ॥

शत. ब्रा. २. ४. २. ८.

"The earlier part is controlled by gods, the middle one by men, and the latter part by the 'pitṛs' (manes)".

The names of three out of five parts have been mentioned in the following ṛk.

उतायातं संगवे प्रातरन्हो मध्यंदिन उदिता सूर्यस्य ॥

दिवानक्तमवसा शंतमेन नेदानीं पीतिरश्विना ततान ॥

ऋ. सं. ५. ७६. ३.

Here the 3 parts, 'prātah, sangava and madhyāhna' have been mentioned by name and hence all the five parts can be inferred from them.

देवस्य सवितुः प्रातः प्रसवः प्राणः ॥ वरुणस्य सायमासवोपानः ॥ यत्प्रतीचीनं प्रातस्तनात् ॥ प्राचीनँसंगवात् ॥ ततो देवा अग्निष्टोमं निरमिमत ॥ तत्तदात्तवीर्यं निर्मार्गः ॥ मित्रस्य संगवः ॥ तत्पुण्यं तेजस्व्यहः ॥ तस्मात्तर्हि पशवः समायंति ॥ यत्प्रतीचीनँ संगवात् ॥ प्राचीनं मध्यंदिनात् ॥ ततो देवा उक्थ्यं निरमिमत ॥ तत्० ॥ बृहस्पतेर्मध्यंदिनः ॥ तत्पु० ॥ तस्मात्तर्हि तेक्ष्णिष्ठ तपति ॥ यत्प्रतीचीनं मध्यंदिनात् ॥ प्राचीनमपराह्णात् ॥ ततो देवाः षोडशिनं निरमिमत ॥ तत्तदा० ॥ भगस्यापराह्णः ॥ तत्पु० ॥ तस्मादपराह्णे कुमार्यो भगमिच्छमानाश्चरंति ॥ यत्प्रतीचीनमपराह्णात् ॥ प्राचीनँ सायात् ॥ ततो देवा अतिरात्रं निरमिमत ॥ तत्तदा० ॥ वरुणस्य सायं ॥ तत्पु० ॥ तस्मात्तर्हि नानृतं वदेत् ॥

तै. ब्रा. १. ५. ३.

This clearly gives the names of the five parts, *viz.*, prātaḥ, sangava, madhyāhṇa, aparāhṇa and sāyaṁ.

आदित्यस्त्वेव सर्वं ऋतवः। यदैवोदेत्यथ वसंतो यदा संगवोथ ग्रीष्मो यदा मध्यंदिनोथ वर्षा
यदापराह्णोथ शरद्यदैवास्तमेत्यथ हेमंतः ॥ शत. ब्रा. २. २. ३. ९.

तस्मा उद्यन्त्सूर्यो हिंकृणोति संगवः प्रस्तौति मध्यंदिन उद्‌गायत्यपराह्णः प्रतिहरत्यस्तं
यन्निधनं ॥ अथ. सं ९. ६. ४६.

Here the names 'sangava', 'madhyaṁdina', and 'aparāhṇa' do not seem to denote the parts of the day, but the transition moments of the four 'praharas' of the day.

Mādhava, in his work *Kālamādhava*, while considering the five-fold division of the day, quotes the abovementioned anuvāk from Taittirīya Brāhmaṇa and observes that "the passage seems to describe the creation of the four systems of soma-sacrifices known as 'agniṣṭoma', 'ukthya' 'ṣoḍaśi and 'atirātra' which are to be performed at the four transition moments in the five divisions of the day and remarks that the five-fold division of the day is found in many 'śruti's and 'smṛti's.' The line* "*pradoṣānto homakālaḥ sangavāntaḥ prātaḥ*" occurs in the *Āśvalāyana Sūtra* shows that 'sangava' is a part of the day and not a transition moment between two parts.

FIFTEEN MUHŪRTAS

The Taittirīya Brāhmaṇa states the names of 15 muhūrtas (or parts) of the day and similar 15 of the night.

अथ यदाह ॥ चित्रः केतुर्दाता प्रदाता सविता प्रसविताभिशास्तानुमंतेति ॥
एष एव तत् ॥ एषह्येव तेन्हो मुहूर्ताः ॥ एष रात्रेः ॥
तै. ब्रा. ३. १०. ९.

The divisions referred to in the above lines have all been mentioned in a single anuvāk in the same Brāhmaṇa a little earlier. They are :—

चित्रः केतुः प्रभानाभान्त्संभान् ॥ ज्योतिष्माँस्तेजस्वानातपँस्तपन्नभितपन् ॥
रोचनो रोचमानः शोभनः शोभमानः कल्याणः ॥
तै. ब्रा. ३. १०. १.

These are the names of 15 muhūrtas of the day in the light half of the month ; each line mentions five and in all they are fifteen in number.

दाता प्रदाताऽनंदो मोदः प्रमोदः ॥ आवेशन्निवेशयन् सँवेशनः संशांतः शांतः ॥
आभवन् प्रभवन् संभवन् संभूतो भूतः ॥
तै. ब्रा. ३. १०. १. १. २.

*Translation—'The ending moment of the 'pradoṣa' part is the proper time for offering oblations into fire and the end of 'sangava' is termed 'prātaḥ'.'

These are the names of the 15 mūhurtas of the night* in the light half.

सविता प्रसविता दीप्तो दीपयन् दीप्यमानः ॥ ज्वलन् ज्वलिता तपन्
वितपन् संतपन् ॥ रोचनो रोचमानः शुंभूः शंभमानो वामः ॥

तै. ब्रा. ३. १०. १. २.

These are the names of the 15 muhūrtas of the day in the dark half.

अभिशास्तानुमंतानंदो मोदः प्रमोदः ॥ आसादयन् निषादयन्
सँसादनः सँसन्नः सन्नः ॥ आभूर्विभूः प्रभूः शंभूर्भुवः ॥

तै. ब्रा. ३. १०. १. ३.

These are the names of the 15 muhūrtas of the night in the dark half.

The whole day and night together must have been divided into 30 divisions, just as the month is divided into 30 parts. The post-Vedic works do mention muhūrtas as parts of the day, but they do not mention the names as given above ; the muhūrtas are found to receive different kinds of names.

THE SUB-DIVISIONS OF MUHŪRTAS

Each muhūrta is supposed to be sub-divided into very small equal sub-muhūrtas (15 in number).

अथ यदाह ॥ इदानीं तदानीमिति ॥ एष एव तत् ॥ एषह्येव ते मुहूर्तानां मुहूर्ताः ॥

तै. ब्रा. ३. १०. ६. ६.

"The muhūrtas are further divided into sub-divisions called pratimuhūrtas ; their names being *Idānīm*, *Tadānīm* and others."

The "pratimuhūrtas" are given below :—

इदानीं तदानीमेतर्हि क्षिप्रमजिरं ॥ आशुर्निमेषः फणोद्रवन्नतिद्रवन् ॥
त्वरँस्त्वरमाण आशुरशीयान् जवः ॥

तै. ब्रा. ३. १०. १. ४.

KALĀ AND KĀṢṬHĀ

सर्वेनिमेषा जज्ञिरे विद्युतः पुरुषादधि ॥ कला मुहूर्ताः
काष्ठाश्चाहोरात्राश्च सर्वशः ॥

नारायण उपनिषद् अनु. १.

This line from the *Nārāyaṇa Upanīṣad* mentions "Kalā and Kāṣṭhā" as units of time in addition to the muhūrtas ; and one cannot make out their mutual relation or their relation with other units of time. The remaining parts of the day known as ghaṭis and palas are nowhere to be found in the Vedas.

NAKṢATRAS

Let us now consider the nakṣatras. A few lines from Ṛk Saṁhitā are given below which contain references to nakṣatras, that is, not to particular

*This is obvious from the context.

star groups but to stars in general which are scattered all over the sky. Some of these mantras are found in the Atharva Saṁhitā also.

अप त्ये तायवो यथा नक्षत्रा यंत्यक्तुभिः ।। सूराय विश्वचक्षसे ।।

ऋ. सं. १. ५०. २. अथ. सं. १३. २. १७; २०. ४७. १४.

"The stars and the night escape like thieves on the approach of the all-seeing sun".

अभि श्यावं न कृशनेभिरश्वं नक्षत्रेभिः पितरो द्यामपिंशन् ।।

ऋ. सं. १०. ६८. ११.

The term 'nakṣatra' has been applied to the stars in the above two lines.

In the line, "*Dyauriva smayamāno nabhobhiḥ*" (meaninglike the sky adorned with stars), the word 'nabhas' is used in the sense of stars ; the word "rocanā" also appears in that sense at some other places.

द्यावो न स्तृभिश्चितयंत ।। ऋ. सं. २. ३४. २.

ऋतावानं विचेतसं पश्यंतो द्यामिव स्तृभिः ।।

ऋ. सं. ४. ७. ३.

In these lines the word '*stṛ*' has been used to denote stars.

In the first two ṛcās the word 'nakṣatra' has been used to denote the stars in general and not only those stars which lie on the path of the moon. The term 'nakṣatra', as used in the post-Vedic Sanskrit works, denotes stars in general as well as those lying on the path of the moon.

अथो नक्षत्राणामेषामुपस्थे सोम आहितः ।।

ऋ. सं. १०. ८५. २. अथ. सं. १४. १. २.

"The moon is placed amongst the stars".

Here, the word nakṣatra seems to have been applied only to those stars which are situated in the moon's path.

The Ṛk Saṁhitā does not mention names of all the 27 nakṣatras in the moon's path, but only a few of them. The word 'tiṣya' which occurs in 5-54-13 and 10-64-8 appears to denote the star 'Puṣya'. The name Citrā nakṣatra occurs in 4-51-2 and Revatī in 4-51-47 ; this appears to denote the star 'Revatī'. The next 'ṛcā' mentions two 'nakṣatras' in succession.

सूर्याया वहतुः प्रागात् सविता यमवासृजत् ।। अघासु हन्यंते गावोर्जुन्योः पर्युह्यते ।।

ऋ. सं. १०. ८५. १३.

"The (dowry) of cows which was given by Savitā (sun) had already gone ahead of Suryā. They drive* the cows on the Aghā (Maghā) nakṣatra. The (daughter) was carried away on the Arjunī (Phalgunī) star".

*The verbal root 'han' here does not mean 'to kill'. The Marathi 'hāṇaṇe' is quite current even at present in the Sholapur district in the sense of lashing or beating and driving.

This 'ṛcā' refers to the story that Suryā, the daughter of Savitā, was given to Soma; the cows which were given to him as dowry by the Sun-god, were driven away one day before, *i.e.* on Maghānakṣatra day, the daughter was carried away on the Arjunī-nakṣatra day.

In this 'ṛcā' the word Arjunī has been used in the sense of Phalgunī and 'Aghā' in place of 'Maghā'. These words are mostly absent in the post-Vedic literature ; there is, however, no doubt that they denote the nakṣatras mentioned, because a variant of this very 'ṛcā' appears in the Atharva Saṁhitā as given below.

सूर्याया वहतुः प्रागात्सवितायमवासृजत् ॥ मघासु हन्यंते गावः फल्गुनीषु व्युह्यते ॥

अथ. सं. १४. १. १३.

This verse gives the actual words Maghā and Phalgunī. Similarly, the verse *viz.*,

एता वा इंद्रनक्षत्रं यत्फल्गुन्योप्यस्य प्रतिनाम्न्योर्जुनो
हवै नामेंद्रो यदस्य गुह्यं नामार्जुन्यो वै नामैतास्ताः

शत. ब्रा. २. १. २. ११.

This clearly shows that Arjunī is identical with Phalgunī. In the Yajur-Veda, the word Maghā is used as 'Maghāsu' in plural feminine form so is Aghāsu used here. Similarly, 'Arjunyoḥ' has been used like 'Phalgunyoḥ' in the feminine dual form. Two acts are said to have occurred here in succession just as Maghā and Phalgunī appear in succession*. This order and the gender and number of Aghā and Phalgunī, agree with those given by the Taittirīya Veda and post Vedic astronomical works. This proves beyond all questions that the nakṣatra system described in the Yajur-Veda was fully in vogue in the Rigvedic times.

It has been stated above that the same word, nakṣatra, has been used without distinction by Ṛk Saṁhitā to denote the stars situated in the moon's path and also stars in general ; but at one place in Taittirīya Saṁhitā, we find a distinction made between the two. The following lines have been taken from the description of the horse to be offered in sacrifice.

यो वा अश्वस्य मेध्यस्य शिरो वेद शीर्षण्वान्मेध्यो भवत्युषा वा अश्वस्य
मेध्यस्य शिरः सूर्यश्चक्षुर्वातः प्राणश्चंद्रमाः श्रोत्रं दिशः पादा अवांतरदिशाः
पर्शवोऽहोरात्रे निमेषोर्धमासाः पर्वाणि मासाः संधानान्यृतवोंऽगानि
संवत्सर आत्मा रश्मयः केशा नक्षत्राणि रूपं तारका अस्थानि नभो माँसानि...॥

तै. सं. ७. ५. २५.

"He who knows the head of the sacrificial horse becomes 'Śīrṣaṇvān' and holy. The ūṣā (dawn) is the sacrificial horse's head. The sun is the eye, winds the life, moon the ears, the (four) quarters the legs, other quarters are the ribs ; the day and night represent the winking of the eyes, the half-months are knuckles and the months are the sandhāna (joints); the seasons are the limbs, the year is the soul, the sun beams are the hair, nakṣatras the form and the stars are the bones".

*The words "aryamnah.....................avastāt" occurring in the passage cited on the next page are worth considering.

A good many references to nakṣatras are found in the Taittirīya Śruti. At some places the names of all the nakṣatras and those of their controlling deities have been mentioned. At some other places we get many kinds of descriptions about them, at others, is described the origin of their names, and at still other places, we come across casual references of intermediate stars at random.

The following anuvāk from Taittirīya Saṁhitā mentions all the nakṣatras :—

कृत्तिका नक्षत्रमग्निर्देवताग्नेरुचस्थ प्रजापतेर्धातुः सोमस्यर्चे त्वा रुचे त्वा द्युते त्वा भासे त्वा ज्योतिषे त्वा रोहिणी नक्षत्रं प्रजापतिर्देवता मृगशीर्षं नक्षत्रँसोमो देवतार्द्रा नक्षत्रँरुद्रो देवता पुनर्वसू नक्षत्रमदितिर्देवता तिष्यो नक्षत्रं बृहस्पतिदेवताश्रेषा नक्षत्रँसर्पा देवता मघा नक्षत्रं पितरो देवता फल्गुनी नक्षत्रमर्यमा देवता फल्गुनी नक्षत्रं भगो देवता हस्तो नक्षत्रँसबिता देवता चित्रा नक्षत्रमिंद्रो देवता स्वाती नक्षत्रं वायुर्देवता विशाखे नक्षत्रमिंद्राग्नी देवतानूराधा नक्षत्रं मित्रो देवता रोहिणी नक्षत्रमिंद्रो देवता विचृत्तौ नक्षत्रं पितरो देवताषाढा नक्षत्रमापो देवताषाढा नक्षत्रं विश्वेदेवा देवता श्रोणा नक्षत्रं विष्णुर्देवता श्रविष्ठा नक्षत्रं वसवो देवता शतभिषङ्नक्षत्रमिंद्रो देवता प्रोष्ठपदा नक्षत्रमजएकपाद्देवता प्रोष्ठपदा नक्षत्रमहिर्बुध्नियो देवता रेवती नक्षत्रं पूषा देवताऽश्वयुजौ नक्षत्रमश्विनौ देवतापभरणीर्नक्षत्रं यमो देवता पूर्णापश्चाद्यत्ते देवा अदधुः ॥

तै. सं. ४. ४. १०.

The Taittirīya Brāhmaṇa gives lists of all the nakṣatras with their deities at three places ; the anuvāk is-quoted below because it gives a quaint description :—

अग्नेः कृत्तिकाः ॥ शुक्रं परस्ताज्ज्योतिरवस्तात् ॥ प्रजापते रोहिणी ॥ आपः परस्तादोषधयोवस्तात् ॥ सोमस्येन्वका विततानि ॥ परस्तात् वयंतोवस्तात् ॥ रुद्रस्य बाहू ॥ मृगयवः परस्ताद्विक्षारोऽवस्तात् ॥ अदित्यै पुनर्वसू ॥ वातः परस्तादार्दमवस्तात् ॥ बृहस्पतेस्तिष्यः ॥ जुह्वतः परस्ताद्यजमाना अवस्तात् ॥ सर्पाणामाश्रेषाः ॥ अभ्यागच्छंतः परस्तादभ्यानत्यंतोवस्तात् ॥ पितृणां मघाः ॥ रुदंतः परस्तादपभ्रंशोवस्तात् ॥ अर्यम्णः पूर्वे फल्गुनी ॥ जाया परस्तादृषभोवस्तात् ॥ भगस्योत्तरे ॥ वहतवः परस्ताद्वहमाना अवस्तात् ॥ देवस्य सवितुर्हस्तः ॥ प्रसवः परस्तात्सनिरवस्तात् ॥ इंद्रस्य चित्रा ॥ ऋतं परस्तात्सत्यमवस्तात् ॥ वायोर्निष्ट्या व्रततिः ॥ परस्तादसिद्धिरवस्तात् ॥ इंद्राग्नियोर्विशाखे ॥ युगानि परस्तात्कृषमाणा अवस्तात् ॥ मित्रस्यानूराधाः ॥ अभ्यारोहत्परस्तादभ्यारूढमवस्तात् ॥ इंद्रस्य रोहिणी ॥ शृणत्परस्तात्प्रतिशृणदवस्तात् ॥ निर्ऋत्यै मूलबर्हणी ॥ प्रतिभंजंतः परस्तात्प्रतिशृणंतोवस्तात् ॥ अपां पूर्वा अषाढाः ॥ वर्चः परस्तात्समितिरवस्तात् ॥ विश्वेषां देवानामुत्तराः ॥ अभिजयत्परस्तादभिजितमवस्तात् ॥ विष्णोः श्रोणा पृच्छमानाः ॥ परस्तात्पंथा अवस्तात् ॥ वसूनां श्रविष्ठाः ॥ भूतं परस्ताद्भूतिरवस्तात् ॥ इंद्रस्य शतभिषक् ॥ बिश्वव्यचाः परस्ताद्विश्वाक्षितिरवस्तात् ॥ अजस्यैकपदः पूर्वे प्रोष्ठपदाः ॥ वैश्वानरं परस्ताद्वैश्वावसवमवस्तात् ॥ अहेर्बुध्नियस्योत्तरे ॥ अभिषिंचंतः परस्तादभिशृण्वंतोवस्तात् ॥ पूष्णो रेवती ॥ गावः परस्तात् वत्सा अवस्तात् ॥ अश्विनोरश्वयुजौ ॥ ग्रामः परस्तात्सेनावस्तात् ॥ यमस्यापभरणाः ॥ अपकर्षंतः परस्तादपवहंतोवस्तात् ॥ पूर्णापश्चाद्यत्ते देवा अदधुः ॥

तै. ब्रा. १. ५. १.

In this we have descriptions of the nakṣatras, which are all of this pattern. "The Kṛttikās belong to Agni ; Śukra is on the other side, and Jyoti is on this side." The rationale and purpose of describing nakṣatras as having one thing on this side and another thing on that side are not fully understood. It appears that the things mentioned here are in reference to the benefic and malefic results relating to nakṣatras in some cases and to their forms in some others. The lines referring to Phalgunī in this passage is very similar to the ṛcā quoted from the Rigveda above. Again, the sentence '*Maitreṇa Kṛṣante*' meaning fields should be ploughed on Anurādhā nakṣatra has been quoted further on.

The reason for this direction perhaps lies in the fact that the preceding nakṣatra Viśākhā has the yoke of the plough on that side, and ploughmen on this side. The words 'yoke' and 'ploughman' appear to have some relation with the figure of the nakṣatra.

The names of all the nakṣatras and their deities, and some quaint and interesting legends about the nakṣatras are found in the Taittirīya Brāhmaṇa Aṣṭakā 3, prapāṭhaka 1 and 2 but these anuvāks cannot be cited here for want of space. They do not specifically mention the deities of nakṣatras, but the relation of the deities with the nakṣatras is in some way suggested in such words as "*agnir naḥ pātu Kṛttikāḥ*". (May Kṛttikās and Agni protect us) "*Ārdrayā Rudraḥ prathamānameti*" (*i.e.* Rudra becomes famous on account of Ārdrā). Similarly, all the nakṣatras with their deities have been mentioned in the 4th and 5th anuvāks of the same 'prapāṭhaka.' These anuvāks are very lengthy. The lines about one nakṣatra, which will give some idea about the other nakṣatras, are quoted below :—

बृहस्पतिर्वा अकामयत ।। ब्रह्मवर्चसी स्यामिति ।। स एतं बृहस्पतये तिष्याय नैवारं चरुं पयसि निरवपत् ।। ततो वै स ब्रह्मचर्यस्यभवत् ।। ब्रह्मवर्चसी ह वै भवति ।। य एतेन हविषा यजते ।। य उ चैनदेवं वेद ।। सोत्र जुहोति ।। बृहस्पतये स्वाहा निष्याय स्वाहा ।। ब्रह्मवर्चसाय स्वाहेति ।।

तै. ब्रा. ३. १. ४. ६.

"Bṛhaspati wished to be holy through spiritual knowledge. He offered to Bṛhaspati and Tiṣya (Puṣya) a '*charu*' (oblation) of '*nïvār*' (rice) in milk. Because of this he became holy. He who offers this oblation in a sacrifice and understands it becomes holy ; while offering the oblation he chants the mantra 'An offering to Bṛhaspati, an offering to Tiṣya, an offering to holy-men".

The nakṣatras and their deities have thus been mentioned in four places. These, together with their gender and number have been shown in one table on page 48 to 50. The differences, if any, regarding the names and deities of nakṣatras have been indicated by numbers 1, 2, 3, and 4 which denote in succession the four places in which they occur. No numbers are given to those nakṣatras about which there is unanimity in all the four places. The wording of the anuvāks from the Taittirīya Saṁhitā shows that the genders and numbers of nakṣatras mentioned in it are the same as those given in other places.

The nakṣatras mentioned by Atharva Saṁhitā are as given in the following lines : —

चित्राणि साकं दिवि रोचनानि सरीसृपाणि भुवने जवानि ।
अष्टाविंशं सुमतिमिच्छमानो अहानि गीर्भिः सपर्यामि नाकम् ।। १ ।।

सुहवं मे कृत्तिका रोहिणी चास्तु भद्रं मृगशिरः शमार्द्रा ।
पुनर्वसू सूनृता चारु पुष्यो भानुराश्लेषा अयनं मघा मे ॥ २ ॥
पुण्यं पूर्वा फल्गुन्यौ चात्र हस्तश्चित्रा शिवा स्वातिः सुखो मे अस्तु ।
राधो विशाखे सुहवानुराधा ज्येष्ठा सुनक्षत्रमरिष्टं मूलम् ॥ ३ ॥
अन्नं पूर्वा रासंन्तां मे अषाढा ऊर्जं ये द्युत्तर आ वहन्तु ।
अभिजिन्मे रासतां पुण्यमेव श्रवणः श्रविष्ठाः कुर्वतां सुपुष्टिम् ॥ ४ ॥
आ मे महच्छतभिषग्वरीय आ मे द्वया प्रोष्ठपदा सुशर्म ।
आ रेवती चाश्वयुजौ भगं म आ मे रयिं भरण्य आ वहन्तु ॥ ५ ॥

अथ. सं. १९. ७.

"I being desirous of welfare, worship the heaven with speeches, because 28 clusters of stars, like wonderful illuminating lights arranged in the form of nimble serpents, shine in the sky" (1st verse).

These lines do not mention any deities for the nakṣatras, and as the first mantra shows, the nakṣatras appear to be 28 in number. The Taittirīya Śruti has mentioned Abhijit nakṣatra in two out of four places ; but nowhere does it mention whether the nakṣatras are 27 or 28. The Śatapatha Brāhmaṇa has stated at one place (10-5-45), that the nakṣatras are 27 and Upanakṣatras are 27. The above lines from Atharva Saṁhitā appear to have used the name Kṛttikā in the singular number. The Mṛgaśiras and Puṣya are mentioned as Mṛgaśiraḥ and Puṣyaḥ (in masculine gender), the word Svātī has been used as Svāti ending short i, and appears to be masculine. The name Anurādhā has the second vowel short and is used in the singular number. The word 'Śravaṇa' has been used (in place of Śroṇa) while the name Bharaṇī is changed to Bharaṇyaḥ. These are the points of difference between the Atharva Saṃhitā and Taittirīya Śruti ; but otherwise the two works show an agreement. The genders and numbers of some of the nakṣatras cannot be clearly ascertained, but one may presume that they are the same as in Taittirīya Śruti. There is, however, some doubt about the Prosṭhapadā. The words "*Vicṛtau nāma tārake*", occurring at some places (2. 8. 1 ; 3. 7. 4) appear to refer to the nakṣatra Mūla.

Nakṣatras mentioned by the Taittirīya Śruti :—

No.	Name of Nakṣatra	The controlling Deity	Gender	Number
1	Kṛttikā	Agni	Feminine	Plural
2	Rohiṇī	Prajāpati	,,	Singular
3	(1, 3, 4) Mṛgaśīrṣa	Soma	Neuter	,,
	(2) Invakā	,,	Feminine	Plural
4	(1, 3, 4) Ārdrā	Rudra	,,	Singular
	(2) Bāhū	,,	Masculine	Dual
5	Punarvasu	Aditi	,,	,,
6	Tiṣya	Bṛhaspati	,,	Singular
7	Āśleṣā	Sarpa	Feminine	Plural

No.	Name of Nakṣatra	The controlling Deity	Gender	Number
8	Maghā	Pitṛ	Feminine	Plural
9	(1, 3, 4) Phalgunī . . .	Aryamā	,,	Dual
	(2) Pūrva Phalgunī . .	,,	,,	,,
10	(1, 3, 4) Phalgunī . . .	Bhaga	,,	,,
	(2) Uttara Phalgunī . .	,,	,,	,,
11	Hasta	Savitā	Masculine	Singular
12	Citrā	(1, 2) Indra	Feminine	,,
		(3, 4) Tvaṣṭā	,,	,,
13	(1) Svātī	Vāyu	,,	,,
	(2, 3, 4) Niṣṭyā . . .	,,	,,	,,
14	Viśākhā	Indrāgni	,,	Dual
15	Anūrādhā	Mitra	,,	Plural
16	(1, 2) Rohiṇī . . .	Indra	,,	Singular
	(3, 4) Jyeṣṭhā . . .	,,	,,	,,
17	(1) Vicṛtau	Pitṛ	Masculine	Dual
	(2) Mūla Barhaṇī . .	Nirṛti	Feminine	Singular
	(3) Mūla	,,	Neuter	,,
	(4) Mūla	Prajāpati	,,	,,
18	(1, 3, 4) Aṣāḍhā . . .	Āpaḥ	Feminine	Plural
	(2) Pūrvāṣāḍhā . . .	,,	,,	,,
19	(1, 3, 4) Aṣāḍhā . . .	Viśvedeva	,,	,,
	(2) Uttarāṣāḍhā . . .	,,	,,	,,
19A	(3, 4) Abhijit . . .	Brahma	Neuter	Singular
20	Śroṇā	Viṣṇu	Feminine	,,
21	Śraviṣṭhā	Vasu	,,	Plural
22	Śataviṣak	(1, 2) Indra	Masculine	Singular
		(3, 4) Varuṇa	,,	,,
23	(1, 3, 4) Proṣṭhapada . .	Ajaekapād	,,	Plural
	(2) Pūrva Proṣṭhapada .	,,	,,	,,
24	(1, 3, 4) Proṣṭhapada . .	Ahirbudhniya	,,	,,
	(2) Uttara Proṣṭhapada .	,,	,,	,,

	Name of Nakṣatra	The controlling Deity	Gender	Number
25	Revatī	Pūṣā	Feminine	Singular
26	Aśvayuja	Aśvin	,,	Dual
27	Apabharaṇī	Yama	,,	Plural

The derivation of the word nakṣatra has been given by Taittirīya Brāhmaṇa in the following lines :—

प्रबादुग्वा अग्रे क्षत्राण्यातेपुः ॥ तेषामिंद्रः ॥ क्षत्राण्यादत्त ॥
नवा इमानि क्षत्राण्यभूवन्निर्तिं ॥ तन्नक्षत्राणां नक्षत्रत्वं ॥

तै. ब्रा. २. ७. १८. ३.

This, in short, appears to mean that those which are not 'Kṣatra' (movable) are Nakṣatras. The Nirukta, explaining that the term nakṣatra is derived from its quality of being *movable* and adds that according to the Brāhmaṇas the nakṣatras are so called because they are not 'Kṣatra' (*i.e.* movable). The Taittirīya Brāhmaṇa at another place writes as follows :—

सलिलं वा इदमंतरासीत् ॥ यदतरन् ॥ तत्तारकाणां तारकत्वं ॥ यो वा इह यजते ॥
अमुं स लोकं नक्षत्र ॥ तन्नक्षत्राणां नक्षत्रत्वं ॥ देवगृहा वै नक्षत्राणि ॥ य एवं वेद ॥
गृह्येवभवति ॥ यानि वा इमानि पृथिव्याश्चित्राणि ॥ तानि नक्षत्राणि ॥ तस्मादश्लीलनामं
श्चित्रे ॥ नावस्येन्नयजेत ॥ यथा पापाहे कुरुते ॥ तादृगेव तत् ॥

तै. ब्रा. १. ५. २.

"There was water in the centre. The tārakās (stars) are said to possess the property of tārakatva (protectiveness) because they floated and saved themselves. He who performs a sacrifice here goes (nakṣate) to that world. Hence is the 'nakṣatra' significantly so called. They are the houses of gods. He who knows this becomes the owner of a house. The nakṣatras are the images of the earthly objects. Hence a rite should not be allowed to terminate and a sacrifice should not be performed on an ugly nakṣatra ; it gives the same result as a rite performed on an inauspicious day".

These lines are very important as the derivation of the word *tārakā* appears more to be quibbling, but the second derivation which traces the word to the root "nakṣa" (to go) and the notion that the virtuous in this world should ascend the heaven and become nakṣatras, is noteworthy. Several nations of the world might be cherishing this belief. The idea that the nakṣatras are houses of gods is very important. Here, what can the word 'deva' stand for other than the shining planets, actually moving through the stars? The notion that the nakṣatras are the houses (*gṛhas*) of gods suggested the derivation that what holds (*gṛhṇāti*) a house is a (*graha*) planet and thus the word *graha* (planet) seems to have been applied to resplendent gods like Venus etc.

Looking to the derivation of the word nakṣatra that they are the images or pictures of the earth or earthly objects, it appears that the nakṣatras must have derived their names from their resemblance to particular figures. But some nakṣatras seem to have received their names for other reasons.

Let us, therefore, see the origin of each nakṣatra's name as given by the Vedas. The names Punarvasu, Citrā, Maghā and Revatī out of the 27 names of the nakṣatras, did not originally indicate nakṣatras but were used in a different sense in the Ṛk Saṁhitā. They are quoted here for a better understanding of the nakṣatra names :—

अग्नीषोमा पुनर्वसू अस्मे धारयतं रयिं ॥

ऋ. सं. १०. १९. १.

Sāyanācārya explains the terms Punarvasu as *'punaḥ punarvastārau stotṛṇāmācchādayitārau (devau)'* meaning "the two gods who repeatedly give shelter to those who offer prayers". It is worth remembering that this word is used in the dual form like the star-name Punarvasu.

वाजिनीवती सूर्यस्य योषा चित्रामघा राय ईशे वसूनां ॥

ऋ. सं. ७. ७५. ५.

उषा अदर्शि रश्मिभिर्व्यक्ता चित्रामघा विश्वमनुप्रभूता ॥

ऋ. सं. ७. ७७. ३.

These lines suggest that 'Citrāmaghā' means "one having wonderful wealth". Yāska has rendered the word as a 'store of wealth to be used for charity'.

The term 'Revatī' means one 'possessing wealth'. The following quotations may be seen for this sense :—

मघमिति धननामधेयं महतेर्दानकर्मणः

निरुक्त १. ७.

स्वस्ति पथ्ये रेवति

ऋ. सं. ५. ५१. १४.

उपमास्वबृहती रेवतीरिषोधि स्तोत्रस्य पवमान नोगहि ॥

ऋ. सं. ९. ७२. ९.

Some of the words in these four have been used in the above mentioned or similar sense in some other places. This shows that the words Punarvasu, Maghā, Citrā and Revatī while already current in the spoken language might have been applied to particular nakṣatras later on, and it can be inferred that these must have been so applied to different nakṣatras, because of their loveliness, their munificence, etc., these qualities being either actually noticed, imagined or experienced about them. The same thing could be said about some other nakṣatras also.

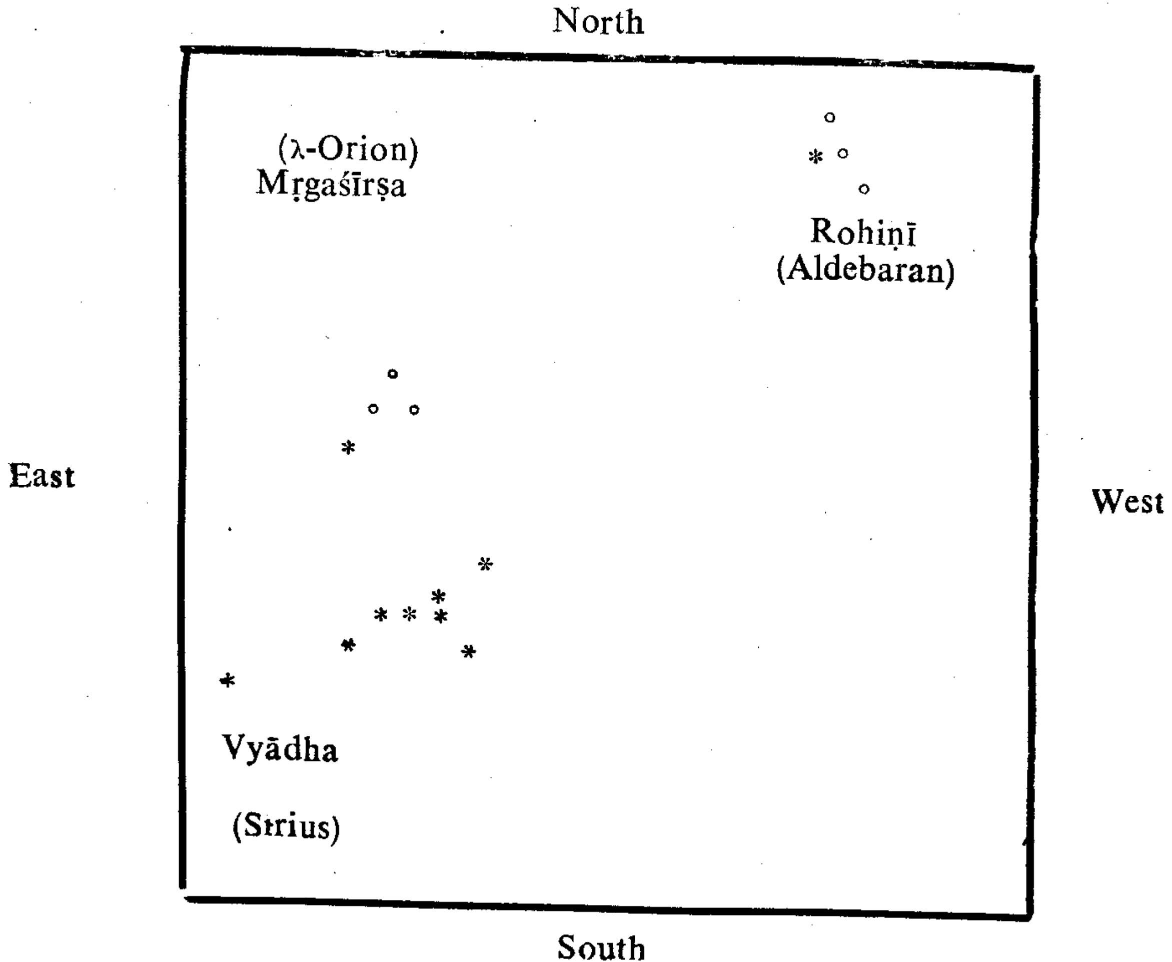
The Aitareya Brāhmaṇa contains a strange legend about Rohiṇī (Aldebaran), Mṛga (Lambda Orionis) and Mṛga Vyādha (Sirius) which gives the reasons for these appelations and hence it is given below :—

प्रजापतिर्वै स्वां दुहितरमभ्यध्यायद्दिवमित्यन्य आहुरुषसमित्यन्ये तामृश्यो भूत्वा रोहितं भूतामभ्यैत् तं देवा अपश्यन्नकृतं वै प्रजापतिः करोतीति ते तमैच्छन्य एनमारिष्यत्येतमन्योन्यस्मिन्नाविदंस्तेषां या एव घोरतमास्तन्व आसंस्ता एकधा समभरंस्ता संभृता एष देवोभवत्तदस्यै तद्भूतवन्नाम भवति वै स योस्यैतदेवन्नाम वेद तं देवा अब्रुवन्नयं वै प्रजापतिरकृतमकरिमं विध्येति

सतथस्यब्रवीत्स वै वो वरं वृणा इति वृणीष्वेति स एतमेव वरमवृणीत पशूनामाधिपत्यं तदस्यैतत्पशुमन्नाम पशुमान् भवति योस्यैतदेवं नाम वेद तमभ्यायत्याविध्यत्स विद्ध ऊर्ध्वं उदप्रपत तमेतं मग इत्याचक्षते पर उ एव मृगव्याधः स उ एव स या रोहित् सा रोहिणी यो एवेषुस्त्रिकांडासो एवेषु त्रिकांडा तद्वा इदं प्रजापतेरेतस्सिक्तमधावत्तत् सरोभवत् ॥

ऐ. ब्रा. १३. ६.

"Prajāpati felt love for his own daughter—the sky, some say, the ūṣā (dawn) others. She became a *rohit* i.e. a deer. He became a '*ṛśya*' (a white footed antelope) and went up to her. The gods saw him and (began to remark) 'Prajāpati is now doing a deed improper'. They sought one who would punish him ; but they did not find any one among them. Then they brought together in one place their most dreadful forms. Brought together, they became a deity, therefore his name contained the word *Bhūta*. He was then born who knows thus his name. To him the gods said, 'Prajāpati here hath done a deed unknown, pierce him'. 'Be it so', he replied, 'Let me choose a boon from you'. 'Choose' (they said). He chose this boon, 'The over lordship of cattle'. Therefore does his name contain the word "cattle". He who thus knows his name becomes rich in cattle. Having aimed at him, he pierced him, being pierced he flew upwards, him they call the 'deer'. The piercer of the deer is he of that name (Mṛgavyādha). The female deer is Rohiṇī. The (Trikāṇḍa) is the three pointed arrow."



In this figure ten stars have been shown in the Orion group. The group of three stars appearing in a straight line and situated in the middle are known as *Trikāṇḍa Bāṇa* or three-pointed arrow. The four stars around it are the four feet of the antelope, and the small cluster of three stars to the north of all these stars is known as the Mṛgaśīrṣa (head of the antelope)

Many more small stars can be seen near these stars in the sky. All these stars together are called the Orion by European astronomers. A look at all the stars in the figure will show that the stars Rohiṇī, Mṛga and Mṛgaśīrṣa must have derived their names from the figures of the star-groups. Again, when these clusters after having risen in the east, begin to move towards the west, it appears as if the Mṛga (the antelope) is chasing Rohiṇī (the deer) and Vyādha (hunter) is chasing the antelope, and the legend of Rohiṇī and Prajāpati might have been suggested by this scene.

The Taittirīya Brāhmaṇa (1. 1. 10) gives the legend of Rohiṇī and Prajāpati in a slightly different form. The purport of the legend is :—

Prajāpati created 'prajā' (people). In so doing, the virāṭ (Universe) was created from his semen. Gods and demons received it. Prajāpati said 'She is mine'. She flew to the east. Prajāpati followed her. She thus ran for protection from place to place. In the end it is remarked :—

सा तत उर्ध्वारोहत् ॥ सा रोहिण्यभवत् ॥ तद्रोहिण्यै रोहिणित्वं ॥ रोहिण्यामग्निमादधीत ॥
स्व एवैनं योनौ प्रतिष्ठितमाधत्ते ॥ ऋध्नोत्येनेन ॥

तै. ब्रा. १. १. १०. ६.

"She then ascended (the heaven). Hence, she came to be known as Rohiṇī. She got this name Rohiṇī, because she ascended heavenward. One should light fire on the 'Rohiṇī' nakṣatra".

The star got the name Rohiṇī because she ascended heaven. The origin of the word Rohiṇī has been given at another place as follows :—

प्रजापति रोहिण्यामग्निमसृजत ॥ तं देवा रोहिण्यामादधत ॥ ततो वै ते सर्वान् रोहानरोहन् ॥
तद्रोहिण्यै रोहिणित्वं ॥ रोहिण्यामग्निमाधत्ते ॥ ऋध्नोत्येव ॥ सर्वान् रोहान् रोहति ॥

तै. ब्रा. १. १. २.

The Taittirīya Brāhmaṇa describes the origin of names of some other stars also as in the following verse :—

देवा वै भद्राः संतोग्निमाधित्संग ॥ तेषामनाहितोग्निरासीत् ॥ अथैभ्यो वामं वस्वपाक्रामत् ॥ ते
पुनर्वस्वोरादधत ॥ ततो वै तान् वामं वसुपावर्तत ॥ यः पुरा भद्रः सन् पापीयान्त्स्यात् ।
स पुनर्वस्वोरग्निमादधीत् ॥ पुनरेवैनं वामं वसुपावर्तते ॥ भद्रो भवति ॥

तै. ब्रा. १. १. २.

"The gods when in good condition desired to light sacrificial fire. (But) their fire remained unlighted, and because of this, their precious wealth left them. They commenced a sacrifice on Punarvasu nakṣatra. The wealth again came back to them."

Other ideas based on the words 'Punaḥ' (again) and 'Vasu' (wealth) can be seen at two or three other places.

The origin of the names of Anurādhā, Jyeṣṭhā etc. has been described in the following lines :—

अन्त्रेषामरात्स्मेति ॥ तदनूराधाः ॥ ज्येष्ठमेषामवधिष्मेति ॥ तत् ज्येष्ठघ्नी ॥ मूलमेषाम-वृक्षामेति ॥ तन्मूलबर्हणी ॥ यन्नासहंत ॥ तदषाढाः ॥ यदश्रोणत् ॥ तच्छ्रोणा ॥ यदशृणोत् ॥ तच्छ्रविष्ठाः ॥ यच्छतमभिषज्यन् ॥ तच्छतभिषक् ॥ प्रोष्ठपदेषूदयच्छंत ॥ रेवत्यामरवंत ॥ अश्वयुजोरयुंजत ॥ अपभरणीष्वपावहन् ॥

तै. ब्रा. १. ५. २.

Sāyana, while commenting on this, remarks that it was the statement made by the gods with reference to their battle with the demons.... (gods say) "we killed the eldest of them all on the Jyeṣṭhā nakṣatra (day) and that is why the star is to be known as 'Jyeṣṭhaghnī'..........etc."

The five stars of the constellation of Hasta present the appearance of the palm of the hand ; and it is clear that the group of stars must have received the name Hasta (hand) from this resemblance.

The Taittirīya Brāhmaṇa has conjured up the vision of nakṣatrīya (stellar) Prajāpati which is noteworthy.

यो वै नक्षत्रियं प्रजापतिं वेद ॥ उभयोरनं लोकयोर्विदु : ॥ हस्त एवास्य हस्तः ॥ चित्रा शिरः ॥ निष्ट्या हृदयं ॥ ऊरू विशाखे ॥ प्रतिष्ठानूराधाः ॥ एष वै नक्षत्रियः प्रजापति : ॥

तै. ब्रा. १. ५. २. २.

"He who knows the nakṣatrīya Prajāpati knows him as related to both the worlds. The star Hasta is his hand, Citrā his head, Niṣṭyā (Svātī) his heart, the two Viśākhā stars his thighs, Anurādhā the place to stand upon. This is the nakṣatrīya Prajāpati".

Even at the present day the description appears to agree if we look up to the sky and imagine that the figure is formed of a man having raised one hand to one side above his head. Only the star Svātī does not seem to fit in at the place of the heart. The proper motion of this star is far greater than that of others. Therefore, the description must have been true sometime in a very remote past.

The grammatical number in which the nakṣatra names are used is helpful as an indication of the number of stars in each group. The Mṛgaśīrṣa group, including the stars representing the head, consists of a good many stars and is called Mṛgaśīrṣa. Similarly all the stars of the Hasta group have together received the appellation Hasta. Thus, though Mṛgaśīrṣa and Hasta are spoken of in the singular number they are actually composed of a number of stars. As mentioned above the alternative name for Mṛgaśīrṣa is '*Invakāḥ*' which is in the plural number. The following ten out of the remaining nakṣatras are used in the singular.

Rohiṇī, Ārdrā, Tiṣya, Citrā, Svātī, Jyeṣṭhā, Mūla, Śroṇā, Śatabhiṣak and Revatī.

This shows that each of these nakṣatras must be a single star. Punarvasu P. Phalgunī, U. Phalgunī, Viśākhā and Aśvayuja—these five stars are used in the dual number ; hence they must have two stars each. The remaining

nakṣatras viz. Kṛttikā, Āśleṣā, Maghā, Anurādhā, P. Aṣādhā, U. Aṣādhā, Sraviṣṭhā, P. Proṣṭhapada, U. Proṣṭhapada and Apabharaṇī, these 10 nakṣatras are used in the plural. Therefore, each of them must have more than two stars. The Kṛttikās, out of them, contained seven stars as can be seen from the following lines :—

अंबायै स्वाहा दुलायै स्वाहा ।। नितत्न्यै स्वाहाभ्रयंत्यै स्वाहा ।।
मेघयंत्यै स्वाहा वर्षयंत्यै स्वाहा ।। चुपुणीकायै स्वाहा ।।

तैं. ब्रा. ३. १. ४.

These are the lines from the Kṛttikeṣṭi (sacrifice to Kṛttikā) a part of nakṣatreṣṭi. The names of seven stars are—

Ambā, Dulā, Nitatnī, Abhrayantī, Meghayantī, Varṣayantī and Cupuṇīkā.

That the Śraviṣṭhā group consisted of four stars may be seen from

चतस्रो देवीरजराः श्रविष्ठा : ।।

तैं. ब्रा. ३. १. २.

The following quotation from Taittirīya Brāhmaṇa (3. 1. 2.), shows that the Proṣṭapada group had also four stars.

प्रोष्टपदासो अभिरक्षंति सर्वे ।। चत्वार एकमभि कर्म देवाः ।। प्रोष्ठादास इतियान् वदंति ।।
ते बुध्नियं परिषद्यंस्तुवंतः ।। अहिंरक्षंति नमसोपसद्य ।।

तैं. ब्रा. ३. १. २.

According to the following lines in the Śatapatha Brāhmaṇa none of the star grups other than the Kṛttikās had more than four stars ; or at any rate none of them had more stars than the Kṛttikās.

एकं द्वे त्राणि चत्वारीति वा अन्यानि नक्षत्राण्यथैता एव भूयिष्ठा यत्कृत्तिकाः ।।

शत. ब्रा २. १. २. २.

"Other nakṣatras have one, two, three, or four only, these Kṛttikās have many".

The number of stars in the nakṣatras and their deities mentioned in the post-Vedic astronomical works will be compared with those in the Taittirīya Śruti later on in Part II.

The Vedas specially refer to certain stars in addition to the 27 well known stars :—

अमी य ऋक्षा निहितास उच्चा नक्तं ददृशे कुह चिद्दिवेयु: ।।

ऋ. सं. १ २४. १०.

"These Bears* which appear to be placed at high elevation (in the sky) at night, go away somewhere in the day."

The Śatapatha Brāhmaṇa observes

सप्तर्षीनु ह स्म वै पुरर्क्षा इत्याचक्षते ।।

श. ब्रा. २. १. २. ४.

*The Saptarsi group has received the name as the Great Bear in European astronomy.

"The Saptarṣis were called bears in ancient times"

There is a reference to the seven stars (Saptarṣis) in Tāṇḍya Brāhmaṇa (1. 5. 5.) which is as follows :—

ऊर्ध्वं सप्त ऋषीनुपतिष्ठस्व ॥

तांडय ब्रा. १. ५. ५.

"Worship the seven sages (appearing) above."

In Taittirīya Brāhmaṇa we come across the following lines in which some reference to the star Citrā occurs after the suggestions that sacrifice should be commenced on the Kṛttikā nakṣatra.

कालकंजा वै नामासुरा आसन् ॥ ते सुवर्गाय लोकायाग्निमचिन्वत ॥ पुरुष इष्टकामुपादधात् पुरुष इष्टकाम् ॥ स इंद्रो ब्राह्मणो ब्रुवाण इष्टकामुपाधत्त ॥ एषा मे चित्रानामेति ॥ ते सुवर्ग लोकमाप्रारोहन् ॥ स इंद्र इष्टकामावृहत् ॥ तेवाकीर्यंत ॥ येवाकीर्यन्त ॥ त ऊर्णाविभयोऽभवन् ॥ द्वावुदपततां ॥ तौ दिव्यौ श्वानावभवतां ॥

तै. ब्रा. १. १. २.

From this it is clear that the words "The two which went up became divine dogs" refer to some two stars or clusters of stars.

शुनो दिव्यस्य यन्महस्तेना ते हविषा विधेम ॥ २ ॥ ये त्रयः कालकंजा दिवि देवा इव श्रिताः ॥ तान्सर्वानह्व ऊतये ॥

अथ. सं. ६. ८०.

This refers to a divine (celestial) dog and three god-like *Kālakanja* (demons) stars in the sky.

यौ ते श्वानौ यम रक्षितारौ चतुरक्षौ पथिरक्षी नृचक्षसौ

ऋ. सं. १०. १४. ११.

This refers to two dogs. Even the Atharva Saṃhitā (18. 2. 12) gives this mantra with the variant reading "Pathiṣadī nṛcakṣasā" for the last two words.

There are two star clusters on either side of the Milky Way situated to the east of Mṛga constellation. They are known as Canis Major and Canis Minor in European astronomy. The first group contains Sirius, one of the brightest stars. The second group contains the pair of southern stars out of the four stars of Punarvasu. It seems these two clusters are the two dogs mentioned in the Vedas.

दैवीं नावं स्वरित्रामनागसमस्रवंतीमारुहेमा स्वस्तये ॥

ऋ. सं. १०. ६३. १०.

This ṛcā refers to the celestial boat. The Atharva Saṁhitā (7. 6. 3) gives this mantra as "*Daivīṃ.. gasoṃ asra..*".

हिरण्मयी नौरचरद्धिरण्यबंधना दिवि ॥ तत्रामृतस्य पुष्पं देवाः कुष्टमवन्वत ॥

अथ. सं. ५. ४. ४; ६. ९५. २.

Even this mantra from the Atharva Saṃhitā mentions a celestial golden boat; the word 'Puṣya' in this appears to have some connection with the star Puṣya. A constellation situated close south of Punarvasu and Puṣya is called *Navis* (Nau or a boat) in the European astronomy. This appears to be the Nau of the Vedas.

ECLIPSES

Let us now see what other astronomical references can be gleaned from the Vedas. Here is a passage from the Ṛk Saṃhitā which mentions an eclipse.

यत्वा सूर्य स्वर्भानुस्तमसाविध्यदासुरः ॥ अक्षेत्रविद्यथामुग्धो भुवनान्यदीधयुः ॥ ५॥
स्वर्भानोरधयींदद्र मायाऽअवो दिवो वर्तमाना अवाहन् ॥
गुल्हं सूर्यं तमसापव्रतेन तुरीयेण ब्रह्मणाऽ विंददत्रिः ॥ ६ ॥
मामामिमं तव संतमत्र इरस्या द्रुग्धो भियसा निगारित् ॥
त्वं मित्रो असि सत्यराधास्तौ मेहावतं वरुणश्च राजा ॥ ७ ॥
ग्राव्णो ब्रह्मा युयुजानः सपर्यन् कीरिणा देवान्नमसोपशिक्षन् ॥
अत्रिः सूर्यस्य दिवि चक्षुराधात् स्वर्भानोरपमाया अघुक्षत् ॥ ८ ॥
यं वै सूर्यं स्वर्भानुस्तमसा विंध्यदासुरः ॥ अत्रयस्तमन्वविंदन्नह्यऽन्ये अशक्नुवन ॥ ९ ॥

ऋ. सं. ५. ४०.

"(5) Oh god Sun! When the demon Rāhu (moon's ascending node) engulfed you with darkness, all the worlds so appeared that people living in them were unable to know where they stood.

(6) Oh Indra ! You destroy the illusions of '*svarbhānu*' (Rāhu) which are found to exist under the sky. The sage Atri got back the Sun who was engulfed by the impious darkness by means of the fourth Brahmā.

(7) Oh sage Atri ! May that malicious demon desirous of devouring food, not devour me with that dreadful darkness. You are a friend and truth is your riches. May you and god Varuṇa protect me here.

(8) The sage Atri, after selecting the grāvā (stone) for extracting some juice for gods and after offering prayers and salutations to them, dispelled the illusions of Rāhu and set his eye on the Sun's light (i.e. remained watching till the Sun became free from darkness)*.

(9) Atri alone could restore the Sun whom the demon Rāhu had engulfed with darkness and no one else could do it."

There are two or three important points in this description. The first thing to note is that this description of the eclipse does not reflect a highly panic-stricken mood. Solar eclipses are quite frequent, but only a few of them are visible at a particular place ; and even out of these few, the total solar eclipse is quite rare. In England, a total solar eclipse was observed on March 20, 1140 A.D. and the next one followed as late as 22nd April, 1715 A.D. which shows that no total solar eclipse was observed during the intervening 575 years. In India, the total solar eclipses do not occur at such long intervals ; nevertheless, they are likely to occur once or twice in one's life time. It is clear

*Sāyanācārya has translated the third line in a different way and his renderign of the other parts of the passage also is slightly different.

that the 'ṛcās' quoted above describe a total eclipse of the sun, still the description does not betray a high degree of amazement or horror. This shows that in those times eclipses had become quite familiar and the dread of that phenomenon had lost much of its edge. Secondly, what are we to understand from the remark that "the Atris alone could restore the sun and no one else could do it"? This perhaps shows that only the members of the Atri family and no one else had the knowledge of the solar eclipse. And what is meant by no one else had that knowledge? Even a child knows it when an eclipse begins. But even then we are told that Atri alone was able to liberate the sun. This means that Atri alone knew when the eclipse would end and no one else had that knowledge which Atri possessed. This shows that the descendants of the Atri family had at least some knowledge of eclipses, if not, the most accurate knowledge necessary for predicting the exact moment of the beginning and ending of an eclipse just as the ancient Chaldeans knew that the eclipses recur with every cycle of 6586 days or 223 lunar months.

Thirdly, though the wish is once expressed in these Ṛks that Rāhu may not devour the sun, it is said three or four times that Rāhu engulfed the sun in darkness, which means that Rāhu and darkness are regarded as two different things. A quotation regarding the belief that the moon enters the sun on the new moon day has already been given from the Aitareya Brāhmaṇa. It appears from this that even though the true cause of a solar eclipse might not have been known at the time of the eclipse mentioned above, one may safely say that the popular beliefs of those times had a leaning towards the knowledge of the true causes. The notion that Svarbhānu or Rāhu devours the sun must have gained ground at a later date.

The *Tāṇḍya Brāhmaṇa* refers to eclipses at five places (4.5.2 ; 4.6.13; 6.6.8 ; 14.11.14.15 ; 23.16.2), in which the 'Svarbhānu' is described as attacking the sun with darkness. In two places (6.6.8 ; 14.11.14, 15) out of five, the sage Atri is said to have removed the darkness by 'bhāsa' (lustre) ; in the remaining three places, gods are said to have removed the darkness ; but even in those places, the word 'gods' appears to mean the sun's rays. In *Gopatha Brāhmaṇa* (8.19), the 'svarbhānu' is described as having attacked the sun by means of 'tama' (darkness) and Atri is said to have driven away that 'tama'. According to a description in the *Śatapatha Brāhmaṇa* (5.3.2.2.) the 'Svarbhānu' is said to have attacked the sun with 'tama' but Soma and Rudra are said to have removed that darkness.

PLANETS

Let us now see what the Vedas have to say about planets. It need not be told that of the nine planets, the Sun and the Moon together share hundreds of references in the Vedas. Rāhu and Ketu are not visible planets at all. Therefore, the remaining five are the only real planets belonging to the sdar system. But the author did not come across any reference in the Vedas in which something is explicitly said about all or any of the five planets. There is, however, ample scope for inference.

अमी ये पंचोक्षणो मध्ये तस्थुर्महो दिवः ॥
देवत्रा नु प्रवाच्यं सध्रीचीना नि वावृतुर्वित्तं मे अस्य रोदसी ॥

ऋ. सं. १. १०५. १०.

"These mighty five (gods) are seen in the middle of the vast expanse of the sky. Even though they are seen coming together when I compose hymns in honour of gods, they have all gone away to-day....".

In this, the word 'gods' does not actually occur. But there is no doubt that the context requires the insertion of the word. The mighty five are said to be coming together. The five planets, Mars and others, are seen very rarely simultaneously in the sky.

Similarly, Mercury and Venus can never be visible in the middle of the sky. Hence, '*divaḥ madhye*' is simply to be rendered as in the sky. All the planets are at some times visible at night except when one or two planets are heliacally set. The original Vedic gods were none other than the wonders of nature, actually visible luminous orbs and so on. Even the root meaning of the word 'deva' is "one who shines". There are no five 'gods' known as 'pañca deva', just as 'two gods' stand for the 'Aśvins' and '33 gods' stand for twelve Ādityas and other deities.

The word 'pañcadeva' occurs also at another place (10.55.3) of the Ṛk Saṁhitā. Hence, the word can be rendered as five planets. It has, already been stated above that "nakṣatras are homes of gods". This statement also lends support to my view, and these very quotations show that the people had some knowledge of planets in the Vedic age.

In these days people of all ages very well recognize the planets Jupiter and Venus and particularly Venus. It appears in the east continuously for some days early morning and then in the west in the evening. It appears in the morning in the east for about 9 months in every span of 20 months. It seems hardly possible that such a bright object as Venus which is visible in the east for about nine months out of twenty and which is bound to attract the attention of all, failed to be a source of joy and wonder to the ancient Ṛṣis who used to awake up and bathe early before dawn and start their sacrificial rites ; and that the Ṛṣis failed to note that it had a motion of its own, quite different from that of other stars—that it was a planet in astronomical parlance.

They had really noticed this fact at the very time when the most ancient Vedic hymns were composed and had accordingly invested Jupiter and Venus with divinity. We are inclined to think that the conception of Aśvins as twin gods probably owes its origin to the two planets Jupiter and Venus. Venus appears in the east early morning for about 9 months out of every 20 ; and almost on every such occasion Jupiter is seen near it for about 2 to 3 months, and in these months it is seen very close to Venus for a few days. Later on, Venus being the faster of the two, Jupiter is seen lagging behind to its west, and is seen rising earlier than Venus every day, and this continues till Jupiter is found to be on the point of setting in the west just when Venus is rising in the east ; Jupiter is thus seen to have traversed the whole sky. It was perhaps sometime when Jupiter and Venus were seen together that Aśvinhood was fancifully conferred on them. Again, when it was seen that Venus for ever remains close to the sun while Jupiter is wandering through the sky the observation must have found expression in the following couplets*.

ईर्मान्यद्वपुषे वपुश्चक्रं रथस्य येमथुः । पर्यन्या नाहुषा युगा मह्ना रजांसि दीयथः ॥

ऋ. सं. ५. ७३. ३.

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*The following note was added at the time when this part of the book was first written on 30th December 1887.

(*See next page*)

"Oh Aśvins ! You have kept one lustrous wheel of your chariot near the sun for adorning him and you revolve round the world by the second wheel."

Of these remarks, the first one *viz.*, 'you have kept the lustrous wheel near the sun' very fittingly applies to Venus and the second *viz.*, 'you revolve round the world by the second wheel' applied to Jupiter equally fittingly.

The Nirukta includes Aśvins in the list of celestial deities. The time prescribed for offering prayers to them was after midnight. The dawn (Ūṣā) was always associated with the Aśvins in some way or the other in the hymns addressed to them in the Rigveda. Habitually rising with the lark, our ancient Ṛṣis were bound to feel the attraction of the sky.

These facts lend support to our surmise and all things considered, we feel convinced that the "Twin Aśvins" were originally none else than the planets Jupiter and Venus.

We come across an independent reference showing that Jupiter was known to be a planet.

बृहस्पतिः प्रथमं जायमानो महो ज्योतिषः परमे व्योमन् ।।

ऋ. सं ४. ५०. ४. अथ. सं २० ८८. ४.

"Jupiter was first born in the highest heaven of shining light."

This sentence occurs also in Taittirīya Brāhmaṇa (2.8.2). The idea conveyed therein seems to be that Jupiter is a god in the form of a star. The Taittirīya Brāhmaṇa further says :—

बृहस्पतिः प्रथमं जायमानः ।। तिष्यं नक्षत्रमभिसंबभूव ।।

तै. ब्रा. ३. १. १.

"Jupiter when born was first visible near the star Tiṣya (Puṣya)".

The maximum latitude of Jupiter is 1° 30′. Hence, there are only 6 out of 27 nakṣatras *viz.*, Puṣya, Maghā, Viśākhā (Alpha Libra), Anurādhā, Śatabhiṣak and Revatī with whom Jupiter can form a close conjunction. Sometimes Jupiter and the star Puṣya are so closely conjoined that they together appear to be one body. The idea of Jupiter having been born near Puṣya star might have arisen when Jupiter was seen emerging from such occultations. Evidently this would call for the knowledge of Jupiter's motion, that is to say, the knowledge that Jupiter was a 'wandering star' or planet. The presiding deity of Tiṣya is Bṛhaspati. Even now the conjunction of Jupiter and Puṣya is regarded as the most auspicious.

Contd. from previous page
Venus rose heliacally in the east on 26th September and Jupiter rose in the east on 21st November. The two, therefore, began to be seen in the eastern sky before dawn from 21st November. Now they are being seen very near together for the last 2 or 3 days. They will come nearest to each other after about two days, *i.e.* on 2nd January 1888, that is to say they will be in conjunction. About 1st of June, while Venus will still be seen rising in the east, Jupiter will be seen on the point of setting in the west, and after a few days Venus will disappear in the east. A gentleman who had no knowledge of astronomy, pointed out to me, of his own accord, early in the morning that two planets were situated near each other. It is not, therefore, possible that the attention of our ancient sages was not drawn to Jupiter and Venus in the same way when they conjoined. —*The Author*

VENUS

अयं वेनश्चोदयत्पृश्निगर्भा ज्योतिर्जराय् रजसोविमाने

ऋ. सं. १०. १२३.

The hymn "this Vena has risen etc." is sung in honour of the deity known as *Vena*. The description in this hymn naturally suggests that it refers to some bright celestial body, that is, to a star or planet ; and descriptions found elsewhere in the Vedas further show that it refers to Venus. The vessels used for storing Soma juice during a sacrifice are called *grahas*. They are so called because they 'take in' i.e., store the Soma juice. When the sacrifice is in progress the juice is first placed in the graha and then oblations are offered thereof which are called *grahás*. Two planets Venus and 'Manthī' are referred to in the Agni-ṣṭoma sacrifice. The Śatapatha Brāhmaṇa makes observations about them as below :—

चक्षुषी हवा अस्य शुक्रामंथिनौ । तद्वा एष एव शुक्रो य एष तपति तद्य देष एतत्तपति तेनैषशुक्रश्चंद्रमा एव मंथी ॥ १ ॥ ......इमामु हैके शुक्रस्य पुरोरुचं कुर्वंति । अयं वेनश्चोदयत्पृश्निगर्भा ज्योतिर्जराय् रजसो विमान इतितदेतस्य रूपं कूर्मो य एष तपतीति यदाहज्योतिर्जरायूरिति ॥ ८ ॥

शत. ब्रा. ४. २. १.

"Śukra (Venus) and Manthī are his eyes. The bright shining body is the same as Śukra, He is called 'śukra' because he shines. The Moon herself is Manthī. Some recite the Ṛcā "*Ayam Venaścodayat*" in the beginning while offering prayers to Śukra. The 'jyoti' is said to be 'jarāyu'.

Its appearance may be described by the words 'he who burns'.

These lines show that Vena and Venus (Śukra) are the same ; here the moon is called the *manthīn* ; but there is also a convention of taking Manthin to mean Saturn.

Śukra is called Venus in Latin. Kupros is the Greek form of Śukra. The Greeks regarded Venus as female deity and hence, the word took the form 'Kupris' and its corresponding Latin form is Cypris ; thus Venus and Kupris or Cypris are equivalents ; and they resemble the words 'Venaḥ' and 'Śukraḥ' in form* .

It appears from this that Venus was known to the Aryans from the time the Greeks and other European Aryans and the Indian Aryans were living together.

वस्व्यसि रुद्रास्यदितिस्यादित्यासि शुक्रासि चंद्रासि बृहस्पतिरस्त्वा सुम्ने रण्वतु

तै. सं. १. २. ५.

"Oh Soma Krayāṇi ! You are Vasvī (i.e. Vasu and other deities) ; you are Rudrā, Aditi and Ādityā ; you are Śukrā and Candrā. May Bṛhaspati bestow happiness upon you in this region."

This is addressed to the Cow who is given away in exchange of Soma juice. Ādityā is one related to Āditya ; this is used in feminine gender because it qualifies the cow. Śukrā and Candrā are similar feminine forms ; here also the word Śukrā appears to refer to Venus.

*This resemblance was suggested to the author by Mr. Bal Gangadhar Tilak.

उत्पाताः पार्थिवांतरिक्षाच्छं नो दिविचरा ग्रहाः ॥ ७ ॥ शं नो भूमिर्वेपमाना शमुल्कानिर्हतं च यत् ॥ ८ ॥ नक्षत्रमुल्काभिहतं शमस्तु ॥ ९ ॥ शं नो ग्रहाश्चांद्रमसाः शमादित्याश्च राहुणा ॥ शं नो मृत्युर्धूमकेतुः शं रुद्रास्तिग्मतेजसः ॥ १० ॥

अथ. सं . १९. ९.

From this it is clear that at the time of the composition of Atharva Veda the term graha has come to be applied to some celestial bodies. The words "May the cāndramasa graha and Āditya graha along with Rāhu prove auspicious to you" seem to refer to the planets eclipsing the sun and moon ; and the additional remark "May the planets moving in the sky bring happiness to you" appears to have been made with reference to planets such as Venus.

The German Professor Weber* who is of opinion that the Hindus have borrowed even the nakṣatras from the Babylonians declares that it appears from the names of planets that the Hindus discovered them independently.

On the whole, we feel that the Indian people had the knowledge of the planets Venus and Jupiter in the Vedic age ; and if this be true, it is not improbable that they might have had some knowledge also of Mars who sometimes appears as bright as Jupitre, ro of Mercury who always remains near the Sun, and of the slow moving planet Saturn.

METEORS AND COMETS

The quotations from Atharva Saṁhitā (19.9) given above contain the words *Ulkā* (Meteors) and *Dhūmaketu* (Comets). Varāhamihira has extensively dealt with the results of a meteor striking against a star.

AUSPICIOUS TIME

Even in the Vedic age people believed that an auspicious time is necessary for doing anything.

स्तोतारं विप्रः सुदिनत्वे आह्नां या यान्नुद्यावस्ततनन्यादुषासः ॥

ऋ. सं. ७. ८८. ४.

"Vipra (intelligent) [Varuṇa] established the reciter of hymns in an auspicious day, after expending the passing days and nights".

The Taittirīya Śruti contains good many instructions for performing the *agnyādhan* and other rites on particular nakṣatras and some of them have already been given above in some context or other. Some more are given below :—

उदितेषु नक्षत्रेषु व्रतं कृणुतेति वाचं विसृजति

तै. सं. ६. १. ४. ४.

"On the rise of nakṣatras he breaks his silence saying 'perform a particular rite".

It is well known that the works on Dharmaśāstra abound in instructions regarding certain rites to be performed till the rise of nakṣatras and in beliefs that certain persons become purified at the sight of nakṣatras.

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*See Weber's *History of the Indian Literature*, Page 251.

यः कामयेत दानकामा मे प्रजाः स्युरिति ॥ स पूर्वयोः फल्गुन्योरग्निमादधीत ॥ अर्यम्णो वा एतन्नक्षत्रं ॥ यत्पूर्वे फल्गुनी । अर्यमेति तमाहुर्यो ददाति ॥ दानकामा अस्मै प्रजाभवंति ॥

तै. ब्रा. १. १. २.

यान्येव देवनक्षत्राणि ॥ तेषु कुर्वीत यत्कारीस्यात् ॥ पुण्याह एव कुरुते ॥

तै. ब्रा. १. ५. २.

यां कामयेत दुहितरं प्रियास्यादिति ॥ तां निष्ट्यायां दद्यात् ॥ प्रियैव भवति ॥

तै. ब्रा. १. ५. २.

(i) "He who is desirous that his progeny should be generous, should commence a sacrifice on the Pūrva Phalgunī day ; because, the Pūrva Phalgunī nakṣatra belongs to aryamā (sun). He who gives away on this nakṣatra comes to be known as 'aryamā'. His progeny has a charitable disposition."

(ii) "Whatever good rites you have to perform, do them on divine nakṣatra days, because they are auspicious days."

(iii) "If you wish that your daughter should be dear to her husband, marry her on the 'Niṣṭyā' (i.e., Svātī) nakṣatra day."

पौष्णेन व्यवस्यंति ॥ मैत्रेण कृषंते ॥ वारुणेन विधृता आसते ॥ क्षैत्रप्रत्येन पाचयंते ॥ आदित्ये नादधते ॥

तै. ब्रा. १. ८. ४.

It appears from the remark '*aślīla nāmaṃścitre*' (on page 50) that just as people had certain notions about the auspicious character of stars, so also they had their notions about the character of days considered apart from the nakṣatras; these lines further show that the nakṣatras were distinguished as evil or good from their names, etc. The principle by which the day was adjusted to be good or evil is, however, not understood. It seems that the nakṣatras received their names from their luminosity, form, and the malefic or benefic nature attributed to them through fancy or experience. To some extent this involves the fallacy or arguing in a circle. But even in the post-Vedic works on astrology we find many a rule framed simply in the light of the significance of names. Thus, for instance, one may be advised to settle a marriage between the bride and bridegroom if they are born, say, under the signs Aries and Leo respectively on the assumption that the ram (Aries) yields easily to the lion (Leo).

COMMENCEMENT OF THE YEAR

Let us now consider as to when the year used to begin in Vedic times. Nowhere in Ṛk Samhitā do we find the names of all the seasons mentioned together ; only the words Sarad and Hemanta occur in many places in the sense of year. As for the other Vedas whenever all the seasons are mentioned, the list invariably begins with Spring. In both the branches of Yajurveda, Spring has been specifically mentioned as the 'mouth of the year' (The quotation have already been given before). The months are named according to the Madhu-Mādhava series, and Madhu and Mādhava are mentioned as the two months of Spring. It is, therefore, proved

beyond doubt that during the Yajurveda Saṁhitā age and during all the Vedic times later, the year used to commence from the month of Madhu and with Spring. The people then might have been occasionally commencing the year from some other season for civil purposes ; but as a rule the year used to commence from Spring. Now the months were lunar and the seasons depend upon solar year ; and if a particular solar year began with the beginning of a lunar year, there being difference of 11 days in the two units of time, the beginning of Spring will not invariably coincide with the beginning of the lunar year and Spring used to set in invariably in the month of Madhu ; there is no doubt that the system of commencing the year with the month of Madhu was in use in the Yajurveda Saṁhitā age and even in later periods.

Some other astronomical features of the Vedic age will be dealt with in the conclusion of Part I.

ASTRONOMY

It seems that the science of astronomy had assumed a tangible shape in the Vedic period. The *Vājasaneyi Saṃhitā* contains the following lines :—

प्रज्ञानाय नक्षत्रदर्शं ॥ वा. सं. ३०. १०.

यादसे गणकं ॥ वा. सं. ३०. २०.

(i) "(Go to) an observer of stars for special knowledge" and

(ii) "a calculator for Yadasa.."

The first of these quotations occurs even in Taittirīya Brāhmaṇa (3. 4. 1). The words *gaṇaka* and *nakṣatra darśa* occur here. The Taittirīya Brāhmaṇa (3. 4. 1) mentions also the names of certain sages who were proficient in these sciences. It is stated at one place that a certain sage named Mātsya got some rite performed on an auspicious nakṣatra and it proved beneficial (1.5.2). The anuvāk which contains the names etc. of the month in a year, the days and nights of the month, and muhūrtas and pratimuhūrtas which has already been quoted above has the following lines at the end :—

जनको ह वैदहः ॥ अहोरात्रैः समाजगाम ॥ तं होचुः ॥ यो वा अस्मान् वेद ॥ विजहत्पाप्मानमेति ॥ ६ ॥ ......अभिस्वर्गं लोकं जयति ॥ ......अहीनाहाऽश्वत्थ्यः ॥ सावित्रं विदांचकार ॥ १० ॥ स ह हँसो......भूत्वा ॥ स्वर्गं लोकमियाय ॥......देवभागो ह श्रौतर्षः ॥ सावित्रं विदांचकार ॥ ११ ॥ ......शूषो ह वार्ष्णेयः आदित्येन समाजगाम ॥

तै. ब्रा. ३. १०. ६.

"The Vaideha Janaka went with 'days and nights'. They told that he who knows them becomes sinless and ascends to heaven. Ahīna, the son of Aśvattha learnt the science of Sāvitra, He became a swan and ascended heaven. Śrautarṣa Devabhāga learnt the science of Sāvitra. The Vārṣṇeya Śūṣa became united with Āditya."

This appears to be partly related to Vedānta philosophy ; but the context shows that it has also some bearing on astronomy. On the whole we are led to conclude that astronomy had grown into an independent science in the Vedic period.

In the above discussion all the Vedic quotations have been considered together. That does not mean, however, that they were all composed and

made known to the people at one and the same time. Hence, it follows that it was not that the astronomical facts embodied in those quotations were all known to them at one time. It is obvious that the astronomical knowledge must have gradually developed as time rolled on.

It would not be correct to infer whatever has not been mentioned in the Vedas was not at all known to the people of Vedic times. The Ṛk Saṁhitā, for instance, refers to eclipse but does not mention all the names of stars. The Taittirīya Śruti, on the other hand, contains references to the nakṣatras by hundreds, but does not refer to eclipses at all. But it would be absurd to presume on this ground that the people then knew nothing of eclipses. Other matters also should receive such judicious consideration.

THE DIVINE DAY

An important sentence may be cited before the close of this chapter.

एकं वा एतद्देवानामहः ॥ यत्संवत्सरः ॥

ते. ब्रा. ३. ६. २२.

"The year is equivalent to a day of the gods."

Gods dwell on the Meru mountain at the North Pole of the Earth, and in the polar regions the day lasts for six months and the night for six months. Hence, the year is known to be equivalent to a 'divine day' in the post-Vedic works on astronomy. Who knows whether this remark emanated from a knowledge of the durations of day and night at the poles or not? Be that as it may, the rationale of the Yuga-measure, as expressed in terms of years in the post-Vedic works, is to a certain extent implicit in this sentence. The next Part will treat this question at a greater length.

SECTION II

THE VEDĀṄGA PERIOD

CHAPTER I—VEDĀṄGAS

1. ASTRONOMY

"Śikṣā, Kalpa, Vyākaraṇa, Nirukta, Jyotiṣa and Chandas" are regarded as the six parts (Aṅgas) of the Vedas. At present a separate Sūtra (Kalpa) for each Veda is available and it is recited generally by the Vaidic Brahmins belonging to each branch (Śākhā); as regards other parts, the Vedas cannot possibly have separate ones. The remaining five parts, which are at present available, are recited by Rigvedi Brahmins only and not by those belonging to other Vedas. The Vedāṅga Jyotiṣa (astronomy) which we hear was recited by Vaidic Brahmins, consists of 36 verses ; but there is another work known as Vedāṅga Jyotiṣa and which is commented upon by Somākara. The commentary by Somākara gives the remark "Yajurvedāṅga Jyotiṣa by Śeṣa" at its end. This portion is not at all different from the one recited by the Rigvedi Brahmins. There is also another work known as Atharva Jyotiṣa. It cannot be said for certain that the three Vedas had originally different "astronomical works" (Vedāṅga Jyotiṣa) ; it will, therefore, be convenient to call them by different names for a clear understanding of the same. Let us call the astronomical work recited by Rigvedi Brahmins as "Rigveda Jyotiṣa" and that which bears the commentary by Somākara as "Yajurveda Jyotiṣa". The Atharva Jyotiṣa is quite a different one. The first two are similar in many respects ; out of 36 verses belonging to Ṛg-Jyotiṣa, 30 are found in the Yajurveda Jyotiṣa also, which has 13 different verses. The total number of verses on astronomy and belonging to the two sections together amount to 49. It is also interesting to note, that of the 30 common verses, one verse is similar in meaning but different in words and metre.

No information regarding Somākara's date, etc. is available and in no other work or commentary is his name found. His commentary is found to be of two kinds. One is an extensive commentary in which Somākara mentions his name in the beginning and adds at the end the remark "The Vedāṅga Jyotiṣa by Śeṣa ends." The second kind is an abbreviation of the first one. It does not mention either Somākara's name or the word "compiled by Śeṣa", etc. Those verses which are very easy to understand or those which deal with mathematics, are left aside ; there is no harm if one thinks that Somākara did not understand the work at all. Even none of other astronomers appears to have attempted to explain the mathematical side of the Vedāṅga Jyotiṣa ; and because it has very little in common with other astronomical works, we seldom find its references in them, and those very few references will be dealt with in subsequent pages. This work is a very ancient one and as such occupies an important place in the history of astronomy. It should, therefore, be fully considered.

In 1879 A.D. Prof. Thibbaut published a small booklet on the translation of Yajurveda Jyotiṣa, which shows that he could succeed in explaining 6 verses more than what Somākara could do. In 1881 A.D. the author attempted to translate as many verses of Yajurveda Jyotiṣa as he could understand. Late Krishna Shastri Godbole had attempted to explain the work but

he could not explain more number of verses than what Prof. Thibbaut could. In 1885 late Janardan Balaji Modak, B. A. published a Marathi translation of Ṛg-Jyotiṣa and Yajur-Jyotiṣa, from which it can be said that he could explain 2 or 3 verses more. He explained only 28 verses out of 49. The author is at present in a position to explain 36 verses out of 49.

At present only the Ṛg-Jyotiṣa is recited by Brahmins. It is not known if Brahmins in any part of India now recite the Yajurveda Jyotiṣa or ever used to do so in the past. There is an interesting thing about the text of Ṛg-Jyotiṣa which is widely in recitation among the Vaidic Brahmins. It is worth noting that a number of verses contains words giving erroneous meaning. The words are incorrect ; still it is interesting to see that these are recited throughout India in this form.

It is no wonder that people regard the text with the same veneration as the Vedas, and hence, a suggestion to the reciter to replace the incorrect form by a correct one would become unacceptable. It is obvious that the astronomical work would not have been erroneous originally ; and hence, the research as to when and how these errors have crept in, would be found very important in the study of the history of the Vedas and Vedāṅgas. It seems that the original Vedāṅga Jyotiṣa must have disappeared some time in the past, and later on some pandit, not understanding the text, must have introduced the recitation of the text from an illegible or incorrectly written edition available to him. This is not the condition of other works connected withVedic literature and hence the above can become a subject of research for the historians of Sanskrit literature. The author has written later on his findings about some of the verses. Of the six Vedāṅgas, Pāṇinī wrote Vyākaraṇa (grammar) ; Piṅgala is the author of Chandaśāstra (metre), and so were Lagadha of Rigveda Jyotiṣa. In the second verse of this astronomical work is written "I am giving the knowledge of time as described by Lagadha." This is somewhat like the recitation of two verses (devoted to the salutation of Pāṇinī) before commencing the recital of *Aṣṭādhyāyī*. It is just possible that Lagadha was not the author of the whole work ; some one might have recast it later on in accordance with Lagadha's suggestions. "लगध" is expressed by the Europeans as 'Lagaḍ' or 'Lagaḍh'. This confusion seems to be due to the fact that the letter ध cannot be properly expressed in roman character, and it is on account of this that Prof. Weber has expressed a doubt that if Lagad be the same person as Laat, he must have lived in the 5th century A. D. But the Sanskrit texts mention the name as 'Lagadha' beyond doubt.*

In what follows, the translation of more important verses common to both the Vedāṅga Jyotiṣas is given first. In the beginning, the Ṛg-Jyotiṣa has been taken up and the text is written exactly in the form in which it is actually recited. If the same verse happens to belong to the Yajurveda, but with a different version given by Somākara and giving a better sense, it is also given later on. These are followed by those verses from the Yajurveda which are not found in Ṛg- Jyotiṣa. Then useful suggestions and criticism are given

* Dr. Kern has published the *Aryabhaṭīya*. He has in its introduction given some quotations from the orginal commentary "*Bhaṭaprakāśikā*" in the Malayalam character. The commentator has, at one place, quoted two verses from Vedāṅga Jyotiṣa as "being written by Lagaḍācārya".

In this he writes the name as "Lagad". The mistake might have been committed because of the similarity of D & DH in the Malayalam character. It is worth seeing if the Brahmins of this province while reciting the Ṛg-Jyotiṣa pronounce the name as "Lagad".

with the verses themselves wherever it was possible to do so. Attempt has been made to retain the originality of the text in the form in which it is recited by Vaidic Brahmins.

For the sake of convenient comparison and contrast, the verse numbers belonging to one of the Vedāṅgas are given in the first column and the corresponding verses belonging to the second Vedāṅga are given in the next column. The first two columns are the analysis of verses belonging to Rigveda Jyotiṣa and the last 3 columns are that of verses belonging to Yajurveda Jyotiṣa.

Analysis of Ṛg-Jyotiṣa				Analysis of Yajur-Jyotiṣa					
R	Y	R	Y	Y	R	Y	R	Y	R
1	1	19	0	1	1	19	11	37	0
2	0	20	22	2	3	20	0	38	16
3	2	21	21	3	36	21	21	39	18
4	13	22	40	4	35	22	20	40	22
5	6	23	41	5	32	23	31	41	23
6	7	24	42	6	5	24	17	42	24
7	8	25	32	7	6	25	0	43	30
8	9	26	33	8	7	26	0		
9	10	27	34	9	8	27	12		
10	15	28	35	10	9	28	0		
11	19	29	0	11	0	29	0		
12	27	30	43	12	0	30	0		
13	0	31	23	13	4	31	0		
14	18	32	5	14	0	32	25		
15	17	33	0	15	10	33	26		
16	38	34	0	16	0	34	27		
17	24	35	4	17	15	35	28		
18	39	36	3	18	14	36	0		

(I) RIGVEDA JYOTIṢA

पञ्चसंवत्सरमयं युगाध्यक्षं प्रजापतिं ।। दिनर्त्वयनमासांगं प्रणम्य शिरसा शुचिः ।। १ ।।

प्रणम्य शिरसा कालमभिवाद्य सरस्वतीं ।। कालज्ञानं प्रवक्ष्यामि लगधस्य महात्मनः ।। २ ।।

"After saluting Prajāpati who is the lord of the five-year Yuga (which consists of the day, the season, the ayana and the month as its parts) I become

purified and then after saluting the god of time and also the goddess of learning (Sarasvatī) I describe the knowledge of time as propounded by the great sage Lagadha".

It is a bit surprising to note that the names of the 5 years comprising the Pañca-Samvatsara-Yuga (five-year-period) are not found in the Vedāṅga Jyotiṣa. But Somākara has quoted some verses belonging to Garga to which the author has referred in his note on the 8th verse. Those verses give a description of Pañca-Samvatsara-Yuga similar to that given by the Vedāṅga Jyotiṣa and they mention names for the five years. The Bṛhat Saṃhitā by Varāhamihira gives the names of years and their Lords. (*See* Bṛhat Saṃhitā 8-10) ; some of these Lords are different from those mentioned by Garga. A line from Taittirīya Brāhmaṇa has already been quoted on page 15 which gives the names of Lords of years ; but they are only four and different in certain respects. These are given below :—

Name of the year	Lords		
	Tai. Brāhm	*Garga*	*Varāha*
1. Samvatsara	Agni	Agni	Agni
2. Parivatsara	Āditya	Āditya	Āditya
3. Idāvatsara	Candramā	Vāyu	Candramā
4. Anuvatsara	Vāyu	Candramā	Prajāpati
5. Idvatsara	....	Mṛtyu	Rudra

निरेकं द्वादशार्धाब्दं द्विगुणं गतसंज्ञिकं ।। षष्ट्या षष्ट्या युतं द्वाभ्यां पर्वणां राशिरुच्यते ।। ४ ।।

If the words "Dvādaśābhyastaṃ" and "Saṃyutaṃ" from Yajur-Jyotiṣa be substituted for "Dvādaśārdhābdaṃ" and "Saṃjñikaṃ" from Ṛg-Jyotiṣa; the above verse can be translated sensibly as follows :—

"Reduce the current year number (out of the 5 year cycle) by one. Multiply the result by 12. Add number of months elapsed. Double the sum. Add 2 for every sixty. The resulting sum is called Parva Rāśi".

Example.—Find the Parva-number (i) in the beginning of the second year of the cycle and (ii) at the end of the 7th month of the 3rd year.

Solution.—(i) Current year number minus one$=2-1=1$. $1\times12\times2$ gives 24. (ii) Current year number$-1=3-1=2$. $(2\times12+7)\times2+2=64$.

This is just like calculating the number of days elapsed from the epoch. This shows that one intercalary month is reckoned after 60 Parvas *i. e.*, after every 30 lunar months. Some verses from Rigveda-version suggest this ; but verse number 37 from Yajur Jyotiṣa definitely mentions the rule.

स्वराक्रमेके सोमार्कौ यदा साकं सवासवौ ।। स्यात्तदादियुगं माघस्तपः शुक्लो दिनंत्यजः ।। ५ ।।

यजुःपाठः—

स्वराक्रमेते सोमार्कौ यदा साकं सवासवौ ।। स्यात्तदादियुगं माघस्तपः शुक्लोयनंह्युदक् ।।

"When the sun and the moon while moving in the sky, come to Vāsava (Dhaniṣṭhā, β-Delphini) star together, then the Yuga, the Māgha (month), the Tapas (season), the light half of the month, and the winter solstice, all commence together."

प्रपद्येते श्रविष्ठादौ सूर्याचांद्रमसावुदक् ।। सार्पार्द्धे दक्षिणार्कस्तु माघश्रावणयोः सदा ।। ६ ।।

Note :—The Yajur-version "Candramasau" is correct and not the version "Cāndramasau."

"The sun and the moon turn towards North in the beginning of Dhaniṣṭhās and towards South in the middle of Āśleṣā. The sun always does this respectively in the months of Māgha and Śrāvaṇa."

The time when the ayanas were possible in Māgha and Śrāvaṇa can be calculated ; this point has been explained at length in the end.

धर्मवृद्धिरपांप्रस्थः क्षपा-ह्लास उदग्गतौ ।। दक्षिणेतौ विपर्यस्तौ षण्मुहूर्त्ययनेन तु ।। ७ ।।

"During the sun's northward journey the day increases by one Prastha-measure of water and the night becomes short. During the southward journey, the conditions reverse. The increase (of time) during an ayana is equal to six muhūrtas."

An increase of one Prastha is equivalent to 4/61 nāḍikā. In this connection, verse no. 17 may also be seen. At the end of this topic, it is fully discussed as to where an increase of six muhūrtas is possible.

द्विगुणं सप्तमं चाहुरयनाद्यं त्रयोदश ।। चतुर्थं दशमं चैव द्वियुग्माद्यं बहुलेप्यृतौ ।। ८ ।।

यजुःपाठ—प्रथमं सप्तमं चाहुरयनाद्यं त्रयोदशं ।।

(The Yajur-version should be accepted for rational meaning).

"The Ayanas commence twice on the Pratipadā, Saptamī, Trayodaśī, Caturthī and Daśamī. They are respectively the commencing tithis of both the ayanas which can occur even in dark half of a month."

The 1st, 7th and 13th of the light half and the 4th and 10th of the dark half are these very 5 tithis occurring again, form the 10 beginning tithis of 10 ayanas occurring in the 5 years; and because the ayanas take place in Māgha and Srāvaṇa, the tithis alternately belong to the two ayanas and hence to the months of Māgha and Srāvaṇa.

That the above verse is to be rendered in this very particular way is supported by the quotations of Garga given with reference to this portion of Vedāṅga Jyotiṣa.

In this verse, the words 'first, seventh, etc.' are used in neuter gender, while the word 'tithi' is used in feminine or sometimes in masculine and not in neuter gender ; this no doubt creates a difficulty. The author has, therefore, taken them to be adjectives qualifying the word 'day' (Dinam). They are to be regarded as tithis and not civil days of a civil month, since no such specific mention is made, nor does it agree with the Vedāṅga Jyotiṣa system.

वसुस्त्वष्टाभगोजश्च मित्रः सर्पाश्विनौ जलं ।। धाता कश्चायनाद्याश्चार्धपंचनभस्त्वृतुः ।। ९ ।।

यजुःपाठ—

वसुस्त्वष्टाभवोजश्च मित्रः सर्पाश्विनौ जलं ।। धाता कश्चायनाद्यास्युरर्धपंचनभस्त्वृतुः ।।

"Vasu, Tvaṣṭā, Bhava, Aja, Mitra, Sarpa, the two Aśvinas, Jala, Dhātā and Brahmā are the Lords of the nakṣatras (*viz.* Dhaniṣṭhā, Citrā, Ārdrā, Pūrva Bhādrapadā, Anurādhā, Āśreṣā, Aśvayuja, Pūrvāṣāḍhā, Uttara Phalgunī and Rohiṇī) with which the ayanas begin ; one Ṛtu (season) is equivalent to 4½ nakṣatras."

The first ayana in the 5th year commences on Uttara Phalgunī and its Lord, according to Vedāṅga Jyotiṣa, is Aryamā and hence the word Dhātā will have to be translated as Aryamā (this is a difficulty). The nakṣatras alluded to in the verse are lunar mansions.

The meaning of the above two verses will be clear from the 'Garga-quotations' given by Somākara in the following verses.

अयनान्यृतवो मासाः पक्षास्त्नृक्षं तिथिर्दिनं ॥ तत्वतो नाधिगम्यंते यदाब्दो नाधिगम्यते ॥ १ ॥
यदातु तत्वतोब्दस्य क्रियतेधिगमो बुधैः ॥ तदैबेषाममोहः स्यात् क्रियाणां चापि सर्बशः ॥ २ ॥
तस्मात्संवत्सराणां तु पंचानां लक्षणानि च ॥ कर्माणि च पृथक्त्वेन दैवतानि च वक्ष्यति ॥ ३ ॥
यदा माघस्य शुक्लस्य प्रतिपद्युत्तरायणं ॥ सहोदयं श्रविष्ठाभिः सोमार्कौ प्रतिपद्यतः ॥ ४ ॥
तदात्र नभसः शुक्लसप्तम्यां दक्षिणायनं ॥ सार्पार्द्धे कुरुते युक्तं चित्रायां च निशाकरे ॥ ५ ॥
प्रथमः सोग्निदैवत्यो नाम्ना संवत्सरः स्मृतः ॥ यदा माघस्य शुक्लस्य त्रयोदश्यामुदग्रविः ॥ ६ ॥
युक्ते चंद्रमसा रौद्रे बासवं प्रतिपद्यते ॥ चतुर्थ्यां नभसः कृष्णे तदार्को दक्षिणायनम् ॥ ७ ॥
सार्पार्द्धे कुक्ते सूर्यस्त्वजयुक्ते निशाकरे ॥ द्वितीयश्चार्कदैबत्यः स नाम्ना परिवत्सरः ॥ ८॥
कृष्णे माघस्य दशमीं वासवादौ दिवाकरः ॥ उदीचीं दिशमातिष्ठन् मैत्रस्येऽनुष्णतेजसि ॥ ९ ॥
नभसश्च निवर्तेत शुक्लस्य प्रथमे तिथौ ॥ चन्द्रार्काभ्यां सुयुक्ताभ्यां सार्पार्द्धे वायुदैबतम् ॥ १० ॥
तदा तृतीयं तं प्राहुरिदासंबत्सरं जनाः ॥ सप्तम्यां माघशुक्लस्य वासवादौ दिवाकरः ॥ ११ ॥
अश्विनीसहिते सोमे यदाशामुत्तरां ब्रजेत् ॥ सोमे चाप्येन संयुक्ते सार्पार्द्धस्थो दिवाकरः ॥ १२ ॥
ब्रजेत याम्यां शुक्लस्य श्रावणस्य त्रयोदशीम् ॥ चतुर्थमिन्दुदैवत्यमाहुश्चाथानुवत्सरम् ॥ १३ ॥
फल्गुनीमुत्तरां प्राप्ते सोमे सूर्ये च वासवे ॥ यद्युत्तरायणं कृष्णचतुर्थ्यां तपसो भवेत् ॥ १४ ॥
श्रावणस्य च कृष्णस्य सार्पार्द्धे दशमीं पुनः ॥ रोहिणीसहिते सोमे रवेः स्याद् दक्षिणायनम् ॥ १५ ॥
इद्वत्सरः स विज्ञेयः पंचमो मृत्युदैवतः ॥ एवमेतद् विजानीयात् पंचबर्षस्य लक्षणम् ॥ १६ ॥

The gist of the "Garga-quotations" and the two verses (8 and 9) is explained in the form of a table given below. :—

Year	Commencement of Winter Solstice			Commencement of Summer Solstice		
	Tithi	Sun's Nakṣatra	Moon's Nakṣatra	Tithi	Sun's Nakṣatra	Moon's Nakṣatra
Saṃvatsara	Māgha S 1	Dhaniṣṭhā	Dhaniṣṭhā	Śravaṇa S 7	Half of Āśreṣā	Citrā
Parivatsara	,, S 13	,,	Ārdrā	,, K 4	,,	P. Bhādrapadā
Idāvatsara	,, K 10	,,	Anurādhā	,, S 1	,,	Āśreṣā
Anuvatsara	,, S 7	,,	Aśvinī	,, S 13	,,	P. Aṣāḍhā
Idvatsara	,, K 4	,,	U. Phalgunī	,, K 10	,,	Rohiṇī

जौद्राघःखेश्वेहीरोषाचिन्मूषण्यःसोमाधानः ॥ रेमृघ्राश्वाओजःस्तृष्वोहर्येष्ठाइत्यृक्षा लिंगैः ॥ १४ ॥

This verse should be read as

जौद्रागः खेश्वेहीरोषाचिन्मूषण्यः सूमाधानः ॥ रेमघास्वापोजः कृष्योह ज्येष्ठाइत्यृक्षा लिंगैः ॥

which is the Yajurveda version and a correct one. In this verse 27 nakṣatras have been indicated by symbolic letters as follows :—

1. Jau—Aśvayujau for Aśvinī
2. Drā for Ārdrā
3. Gaḥ—Bhagaḥ for P. Phalgunī
4. Khe for Viśākhe
5. Śve—Viśve (Deva) for U. Aṣāḍhā
6. Hiḥ—Ahirbudhnya for U. Bhādrapadā
7. Ro for Rohiṇī
8. Ṣā for Āśreṣā
9. Cit for Citrā
10. Mū for Mūla
11. Ṣak for Śatabhiṣak
12. Ṇyaḥ for Bharaṇyaḥ
13. Sū for Punarvasū
14. Mā—Aryamā for U. Phalgunī
15. Dhā for Anurādhā
16. Naḥ for Śravaṇaḥ
17. Re for Revatī
18. Mṛ for Mṛgaśīrṣa
19. Ghā for Maghā
20. Svā for Svātī
21. Paḥ—Āpaḥ for P. Aṣāḍhā
22. Ajaḥ—Aja Eka Pād for P. Bhādrapadā
23. Kṛ for Kṛttikā
24. Ṣyaḥ for Puṣyaḥ
25. Ha for Hasta
26. Jye for Jyeṣṭhā
27. Ṣṭhā for Śraviṣṭhā

The list contains the nakṣatras beginning with Aśvinī and then every 6th nakṣatra from it. The symbols are either the beginning letters or the ending letters of nakṣatra names or those of controlling deities.

The theory underlying this is as follows :— It appears from the above* verse and from the 25 verses of Yajur Jyotiṣa that 1 yuga contains 124 parvas and hence one nakṣatra division is supposed to be divided into 124 parts. One yuga contains 1860 tithis and the Sun revolves through the nakṣatras 5 times during a mahāyuga (see Yajur Jyo. verses 28 and 31). Hence the Sun moves through $\frac{5 \times 27 \times 124}{1860}$ *i.e.* 9 parts during one tithi. The following table gives the part (or degree) of a particular nakṣatra which the Sun occupies at the end of each Parva. From this it can be seen that the Sun will be found on the part number which is the ordinal number of nakṣatra in the list. For example : Aśvinī is the first and Ārdrā is the second nakṣatra; whenever the sun would come to Aśvinī (*i.e.* at the end of 5th, 30th, 55th, 79th and 104th parva) the sun would be found to occupy the first part or a multiple of 27 plus one part and when it would come to Ārdrā it would occupy the second part or multiple of 27 plus 2 parts and so on. In the last column of the table is noted the balance which remains after dividing the number of parts of a nakṣatra by 27. Each nakṣatra occupies that place in the list which is indicated by that number. The scheme or the system cited above can not be rightly understood, as the meanings of all the verses are not clear. It is just possible that originally there might have been verses explaining the system, but those verses are now lost for us.

*A nakṣatra is supposed to consist of 610 Kalās (minutes), as given in verses 18 and 21 of Ṛk-version. This number refers to the Moon's motion.

The Sun's position at the end of each Parva in the 5 years of a Yuga.

Month	Serial No. of Parva	Elapsed Nakṣatra	Current Nakṣatra Part	Name	Remainder (27 parts)
		SAMVATSARA			
Māgha	1	1	11	Śatabhiṣak	11
Māgha	2	2	22	P. Bhādrapadā	22
Phālguna	3	3	33	U. Bhādrapadā	6
Phālguna	4	4	44	Revatī	17
Caitra	5	5	55	Aśvayuj	1
Caitra	6	6	66	Bharaṇī	12
Vaiśākha	7	7	77	Kṛttikā	23
Vaiśākha	8	8	88	Rohiṇī	7
Jyeṣṭha	9	9	99	Mṛga	18
Jyeṣṭha	10	10	110	Ārdrā	2
Āṣāḍha	11	11	121	Punarvasū	13
Āṣāḍha	12	13	8	Āśreṣā	8
Śrāvaṇa	13	14	19	Maghā	19
Śrāvaṇa	14	15	30	P. Phalgunī	3
Bhādrapada	15	16	41	U. Phalgunī	14
Bhādrapada	16	17	52	Hasta	25
Āśvina	17	18	63	Citrā	9
Āśvina	18	19	74	Svātī	20
Kārtika	19	20	85	Viśākhā	4
Kārtika	20	21	96	Anurādhā	15
Mārgaśīrṣa	21	22	107	Jyeṣṭhā	26
Mārgaśīrṣa	22	23	118	Mūla	10
Pauṣa	23	25	5	U. Aṣāḍha	5
Pauṣa	24	26	16	Śravaṇa	16
		PARIVATSARA			
Māgha	25	27	27	Śraviṣṭhā	27
Māgha	26	1	38	Śatabhiṣak	11
Phālguna	27	2	49	P. Bhādrapadā	22

Month	Serial No. of Parva	Elapsed Nakṣatra	Part	Current Nakṣatra: Name	Current Nakṣatra: Remainder (27 parts)
	PARIVATSARA—*contd.*				
Phālguna	28	3	60	U. Bhādrapadā	6
Caitra	29	4	71	Revatī	17
Caitra	30	5	82	Aśvayuj	1
Vaiśākha	31	6	93	Bharaṇī	12
Vaiśākha	32	7	104	Kṛttikā	23
Jyeṣṭha	33	8	115	Rohiṇī	7
Jyeṣṭha	34	10	2	Ārdrā	2
Āṣāḍha	35	11	13	Punarvasū	13
Āṣāḍha	36	12	24	Puṣya	24
Śrāvaṇa	37	13	35	Āśreṣā	8
Śrāvaṇa	38	14	46	Maghā	19
Bhādrapada	39	15	57	P. Phalgunī	3
Bhādrapada	40	16	68	U. Phalgunī	14
Āśvina	41	17	79	Hasta	25
Āśvina	42	18	90	Citrā	9
Kārtika	43	19	101	Svātī	20
Kārtika	44	20	112	Viśākhā	4
Mārgaśīrṣa	45	21	123	Anurādhā	15
Mārgaśīrṣa	46	23	10	Mūla	10
Pauṣa	47	24	21	P. Aṣaḍhā	21
Pauṣa	48	25	32	U. Aṣaḍhā	5
	IDĀVATSARA				
Māgha	49	26	43	Śravaṇa	16
Māgha	50	0	54	Śraviṣṭhā	27
Phālguna	51	1	65	Śatabhiṣak	11
Phālguna	52	2	76	P. Bhādrapadā	22
Caitra	53	3	87	U. Bhādrapadā	6
Caitra	54	4	98	Revatī	17
Vaiśākha	55	5	109	Aśvayuj	1
Vaiśākha	56	6	120	Bharaṇī	12

Month	Serial No. of Parva	Elapsed Nakṣatra	Current Nakṣatra		
			Part	Name	Remainder (27 parts)
		IDĀVATSARA—*contd.*			
Jyeṣṭha . . .	57	8	7	Rohiṇī . . .	7
Jyeṣṭha . . .	58	9	18	Mṛga . . .	18
Āṣāḍha . . .	59	10	29	Ārdrā . . .	2
Āṣāḍha . . .	60	11	40	Punarvasū . .	13
Adhika Śrāvaṇa . .	61	12	51	Puṣya . . .	24
Adhika Śrāvaṇa . .	62	13	62	Āśreṣā . . .	8
Śrāvaṇa . . .	63	14	73	Maghā . . .	19
Śrāvaṇa . . .	64	15	84	P. Phalgunī . .	3
Bhādrapada . .	65	16	95	U. Phalgunī . .	14
Bhādrapada . .	66	17	106	Hasta . . .	25
Āśvina . . .	67	18	117	Citrā . . .	9
Āśvina . . .	68	20	4	Viśākhā . . .	4
Kārtika . . .	69	21	15	Anurādhā . .	15
Kārtika . . .	70	22	26	Jyeṣṭhā . . .	26
Mārgaśīrṣa . .	71	23	37	Mūla . . .	10
Mārgaśīrṣa . .	72	24	48	P. Aṣāḍhā . .	21
Pauṣa . . .	73	25	59	U. Aṣāḍhā . .	5
Pauṣa . . .	74	26	70	Śravaṇa . . .	16
		ANUVATSARA			
Māgha . . .	75	0	81	Śraviṣṭhā . .	27
Māgha . . .	76	1	92	Śatabhiṣak . .	11
Phālguna . . .	77	2	103	P. Bhādrapadā .	22
Phālguna . . .	78	3	114	U. Bhādrapadā .	6
Caitra . . .	79	5	1	Aśvayuj . .	1
Caitra . . .	80	6	12	Bharaṇī . .	12
Vaiśākha . . .	81	7	23	Kṛttikā . . .	23
Vaiṣākha . . .	82	8	34	Rohiṇī . . .	7
Jyeṣṭha . . .	83	9	45	Mṛga . . .	18
Jyeṣṭha . . .	84	10	56	Ārdrā . . .	2
Āṣāḍha . . .	85	11	67	Punarvasū . .	13

Month	Serial No. of Parva	Elapsed Nakṣatra	Current Nakṣatra Part	Current Nakṣatra Name	Remainder (27 parts)
		ANUVATSARA—*contd.*			
Āṣāḍha	86	12	78	Puṣya	24
Śrāvaṇa	87	13	89	Āśreṣā	8
Śrāvaṇa	88	14	100	Maghā	19
Bhādrapada	89	15	111	P. Phalgunī	3
Bhādrapada	90	16	122	U. Phalgunī	14
Āśvina	91	18	9	Citrā	9
Āśvina	92	19	20	Svātī	20
Kārtika	93	20	31	Viśākhā	4
Kārtika	94	21	42	Anurādhā	15
Mārgaśīrṣa	95	22	53	Jyeṣṭhā	26
Mārgaśīrṣa	96	23	64	Mūla	10
Pauṣa	97	24	75	P. Aṣāḍhā	21
Pauṣa	98	25	86	U. Aṣāḍhā	5
		IDVATSARA			
Māgha	99	26	97	Śravaṇa	16
Māgha	100	0	108	Śraviṣṭhā	27
Phālguna	101	1	119	Śatabhiṣak	11
Phālguna	102	3	6	U. Bhādrapadā	6
Caitra	103	4	17	Revatī	17
Caitra	104	5	28	Aśvayuj	1
Vaiśākha	105	6	39	Bharaṇī	12
Vaiśākha	106	7	50	Kṛttikā	23
Jyeṣṭha	107	8	61	Rohiṇī	7
Jyeṣṭha	108	9	72	Mṛga	18
Āṣāḍha	109	10	83	Ārdrā	2
Āṣāḍha	110	11	94	Punarvasū	13
Śrāvaṇa	111	12	105	Puṣya	24
Śrāvaṇa	112	13	116	Āśreṣā	8
Bhādrapada	113	15	3	P. Phalgunī	3
Bhādrapada	114	16	14	U. Phalgunī	14

Month	Serial No. of Parva	Elapsed Nakṣatra	Current Nakṣatra Part	Name	Remainder (27 parts)
		IDVATSARA—*contd.*			
Āśvina	115	17	25	Hasta	25
Āśvina	116	18	36	Citrā	9
Kārtika	117	19	47	Svātī	20
Kārtika	118	20	58	Viśākhā	4
Mārgaśīrṣa	119	21	69	Anurādhā	15
Mārgaśīrṣa	120	22	80	Jyeṣṭhā	26
Pauṣa	121	23	91	Mūla	10
Pauṣa	122	24	102	P. Aṣāḍhā	21
Adhika Māgha	123	25	113	U. Aṣāḍhā	5
Adhika Māgha	124	26	124	Śravaṇa	16

कला दश च विंशा स्याद् द्विमुहूर्तस्तु नाडिके ॥
द्विस्त्रिशस्तत्कलानां तु षट्शतीत्र्यधिकं भवेत् ॥ १६ ॥

यजुःपाठ—
कला दश सविंशाः...... ॥ द्युत्रिंशत् तत्...... ॥

"$10\frac{1}{20}$kalās make one 'nāḍikā', two nāḍikās are equal to one 'muhūrta' and 30 muhūrtas or 603 kalās make one day".

नाडिके द्वेमुहूर्तस्तु पंचाशत्पलमाषकं ॥ माषकात्कुंभको द्रोणः कुटपैर्वर्धते त्रिभिः ॥ १७ ॥

The verse does not mention any relation between "Āḍhaka" and "Droṇa". Similarly the 24th verse of Yajur-Jyotiṣa, which gives different wording, does not give any relation. Varāhamihira, in the Varṣaṇādhyāya, says

पंचाशत्पलमाढकमनेन मिनुयाज्जलं पतितं ॥ २ ॥
बृ० सं० २३.

It seems, while writing out this chapter, he must have had before his mind this very verse from Vedāṅga Jyotiṣa. But although he has made use of the term 'droṇa' in the next verse, he does not mention any relation between 'āḍhaka' and 'droṇa'. It may be, he did not find any suitable place wherein to mention this relation, because the four 'quarters' of the verse were already composed. Also, the commentator Bhaṭotpala says, "because 50 palas are said to make one āḍhaka, and four āḍhakas make one droṇa". These parts of a verse so much agree with the 2nd and 3rd quarters of 17th verse of Vedāṅga Jyotiṣa, that Bhaṭotpala appears to have taken the quotation, without doubt, from Vedāṅga Jyotiṣa. Bhāskarācārya and the others have also mentioned 'droṇa' as equivalent to 4 'āḍhakas' and the real verse of Vedāṅga Jyotiṣa ought to run as follows and it will then remain in agreement with the context :—

नाडिके द्वे मुहूर्तस्तु पंचाशत्पलमाढकं ॥ चतुर्भिराढकैर्द्रोणः कुटपैर्वर्धते त्रिभिः ॥ १७ ॥

"One muhūrta=two nāḍikās ; 50 palas=1 āḍhaka; 4 āḍhakas =1 droṇa —this being larger than one nāḍikā by 3 kuḍavas".

Here we have to take for granted the words "Than one nāḍikā". This word occurs in the first quarter and we can take it without much difficulty. The sense which we thus get tallies with the clear meaning of the verse given by the Yajur-Jyotiṣa, which runs thus:

पलानि पंचाशदपां धृतानि तदाढकं द्रोणमतः प्रमेयं ॥
त्रिभिर्विहीनं कुडवैस्तु कार्यं तन्नाडिकायास्तु भवेत्प्रमाणं ॥ २४ ॥

"The vessel known as 'āḍhaka' holds 50 palas of water. Measure one droṇa of water with it. Throw away from it water equal to 3 kuḍavas in volume. Then the time needed for the remaining water (to trickle away) is known as one nāḍikā".

The measure of the unit Kuṭapa (Kuḍava) which occurs in the verse needs understanding. Similarly another unit 'Prastha' denoting some measure of time has occurred before in verse No. 7. Vedāṅga Jyotiṣa does not give any relation between Prastha and Nāḍikā. Let us try to understand it. Bhāskarācārya says,

द्रोणस्तु खार्याः खलु षोडशांशः स्यादाढको द्रोणचतुर्थभागः ॥
प्रस्थश्चतुर्थांश इहाढकस्य प्रस्थांघ्रिराद्यैः कुडवः प्रदिष्टः ॥ ८ ॥

लीलावती .

Meaning :—4 kuḍavas=1 prastha
4 prasthas=1 āḍhaka
4 āḍhakas=1 droṇa

and according to Vedāṅga Jyotiṣa, 50 palas make one āḍhaka. Hence, the following units can be interrelated as

1 droṇa=200 palas=64 kuḍavas. 1 prastha=$12\frac{1}{2}$ palas.
1 āḍhaka=50 palas. 1 kuḍava= $3\frac{1}{8}$ palas.

Also according to Vedāṅga Jyotiṣa, 1 nāḍikā=1 droṇa minus 3 kuḍavas. Hence, 1 nāḍikā=61 kuḍavas=$(200-3\times3\frac{1}{8})$ palas=$190\frac{5}{8}$ palas and 1 prastha =$12\frac{1}{2}$ palas,

$$\text{therefore, 1 prastha}=\frac{12\frac{1}{2}}{190\frac{5}{8}}=\frac{4}{61}\ \text{nāḍikās.}$$

It has been said in the 7th verse above that the day-light increases by 1 prastha per day, and it has been now proved that 1 prastha=4/61 nāḍikās, and this agrees with the theory underlying the method of calculating 'measure of day' (Dinamāna) described in 22nd verse. This shows that we have correctly established the relation between prastha, nāḍikā and other units. It has been proved that 'nāḍikā' stands for that measure of time during which $190\frac{5}{8}$ palas volume of water would trickle away ; but no rule is given as to how to regulate the size of the hole to ensure the correctness of time for a definite volume of water to flow out. It appears that it was considered unnecessary to dilate upon this as the ghaṭikā vessel had come into common use since a long time. According to Amarkośa, Līlāvatī and other works, one pala=4 karṣa =4 tolās of water ; or $190\frac{5}{8}$ palas$\times$4=$762\frac{1}{2}$ tolās ; which amounts to a volume greater than 9 seers of water. The ghaṭikā-vessels which are found in use at present can hold $1\frac{1}{2}$ seers of water at the most. The bigger the vessel in size the greater is the accuracy of time and hence big vessles are always desirable.

The unit of time known as 'pala' appears to have been derived from the time which 1 pala (spoon) full of water takes to trickle out. The pala, therefore, is a unit of volume and of time also. In astronomy the word 'pānīyapala' is found in use to indicate a 'pala-unit' (see Siddhānta Śiromaṇi). According to Vedāṅga Jyotiṣa, a ghaṭikā was not considered to be equivalent to 60 palas but equal to $190\frac{5}{8}$ pānīyapalas. This measure is inconvenient for calculations. However, the work does mention "a day=60 nāḍikās" and it appears that the identity (1 nāḍikā=60 palas) might have come into use ; and just as in Vedāṅga Jyotiṣa, the measure of one nāḍikā has been described as the time for $190\frac{5}{8}$ palas of water to trickle out, so the future generations may begin to define a nāḍikā as the time for 60 palas of water to pass out. It does not matter as to the number of palas which a nāḍikā would consist of ; since, one nāḍikā has always to remain equivalent to 1/60th part of a day, it is constant in value. The relation "1 nāḍikā=60 palas" can be maintained if the size of aperture in the vessel of capacity 60 palas be so adjusted that the water in it would pass out in exactly 1 nāḍikā time. Even at present, people do not care to know as to how much water their "ghaṭikā pātra" (nāḍikā vessel) should hold. They take care to see that the bore is sufficiently small so that the water oozes out exactly in 1 ghaṭikā time. The measure of a nāḍikā as adopted in Vedāṅga Jyotiṣa period no doubt appears very inconvenient, but it will be shown later on that it is really a convenient one.

ससप्तकुंभयुकूस्योन सूर्याद्योनिं त्रयोदश ॥ नवमानि च पंचाह्नः काष्ठाः पंचाक्षराः स्मृताः ॥ १८।

यजुःपाठ—ससप्तमं भयुकू सोमः सूर्यो द्यूनि त्रयोदश ॥

There will be very little change if the word 'Syona' in the first quarter of the Ṛk-verse be replaced by 'Śyena'.

"The moon remains in a nakṣatra for a period of 1 civil day+7 (kalās). The Sun remains there for $13\frac{5}{9}$ days. 5 letters are equal to 1 kāṣṭhā".

A solar year consists of 366 and one Yuga contains $(366\times5)=1830$ civil days (*see* Yajurveda-verse No. 28);and the moon moves through the nakṣatras 67 times during one Yuga (*see* Yajurveda-verse No. 31). The moon, therefore, moves through 67×27 nakṣatras in one yuga. One day consists of 503 kalās. Hence, one yuga contains 1830×603 kalās. The moon, therefore, requires $\frac{1830}{27}\times\frac{603}{67}=610$ Kalā-time ($\doteq$ 1 day 3 kalās) to pass through one nakṣatra. The sun takes 366 days to move through 27 nakṣatras ; hence, it requires $\frac{366}{27}=13\frac{5}{9}$ days to pass through a nakṣatra.

श्रविष्ठाभ्यां गुणाभ्यस्तान्प्राग्विलग्नान् विनिर्दिशेत् ॥

सूर्यान्मासान् षलभ्यस्तान् विद्याच्चांद्रमसान् ऋतून् ॥ १९ ॥

(First half is unintelligible. *Translation of second half* :—"Multiply the solar month by six, the result will be lunar seasons".

Sun's complete revolution through stars is known as a year and 6 seasons occur in this period, so the six lunar seasons will occur in moon's one revolution through the Zodiac. But the moon's one revolution is equal to one solar month. Hence number of solar months multiplied by six will give the period for the moon's seasons. This is an approximate result. According to Vedāṅga Jyotiṣa the moon makes 67 revolutions in 60 solar months, and therefore, one solar month gives rise to $\frac{67\times6}{60}=6\frac{7}{10}$ lunar seasons.

याः पर्वभादानकलास्तासु सप्तगुणां तिथिं ॥

प्रक्षिपेत् कलासमूहस्तु विद्यादादानकीः कलाः ॥ २१ ॥

"To obtain 'Ādāna Kalā' (*i.e.* Bhogya or elapsable number of kalās)at the end of the day falling on a parva, add seven times tithi to the Ādāna Kalās (elapsable kalās) of the nakṣatra(=Bha) on the parva-day in question".

One civil day contains 603 kalās and a nakṣatra is equivalent to 610 kalās. Hence, the moon after passing through 603 kalās in one civil day, still leaves 7 kalās more to be passed over next day ; it thus leaves 14 kalās more after 2 days and so on. The above rule is based on this theory. The tithi here stands for a "civil day".

यदुत्तरस्यायनतोयनं स्याच्छेषं तु यद्दक्षिणतोयनस्य ॥
तदेव षष्ट्या द्विगुणं विभक्तं सद्वादशं स्याद्दिवसप्रमाणं ॥ २२ ॥

यजुःपाठ—

यदुत्तरस्यायनतो गतं स्याच्छेषं तथा दक्षिणतोयनस्य ॥
तदेव षष्ट्या द्विगुणं विभक्तं सद्वादशं स्याद्दिवसप्रमाणं ॥

(The work 'Tadevaṣaṣṭyā' in both these versions must be replaced by 'Tadekaṣaṣṭyā' to give a sensible meaning).

"Find the number of days elapsed after Uttarāyaṇa or number of days yet to go for the Dakṣiṇāyana ; multiply the number by 2 and divide the product by 61. Add 12 to the quotient getting the measure of a day in "muhūrtas".

One can understand the theory underlying the above method from the fact that one year consists of 366 days, one ayana contains 183 and the total increase during this period is 6 muhūrtas. Therefore daily increase over 12 muhūrtas would be $\frac{6}{183}$ or $\frac{2}{61}$ muhūrtas or $\frac{4}{61}$ nāḍikās.

EXAMPLE.—Find the "length of the day" on the day just after Uttarāyaṇa commences. The increase $= \frac{1 \times 2}{61}$ muhūrtas. Therefore the 'dinamāna" or length of the day will be $12\frac{2}{61}$ muhūrtas or $24\frac{4}{61}$ nāḍikās.

In verse 7 it has been already stated that the day increases by a prastha, and it was proved in 17th verse that a prastha was equal to $\frac{4}{61}$ nāḍikās. The relation of 61 kuḍavas equal to one nāḍikā is a convenient adoption to avoid lengthy multiplications and divisions.

तदर्धं दिनभागानां सदा पर्वणि पर्वणि। ऋतुशेषं तु तद्विद्यात् संख्याय सहपर्वणाम् ॥ २३ ॥
यजु.पाठ—यदर्धंदिनभागानां... । ऋतु... संख्याय... ॥

(*Yadardham*, has been taken as the correct word).

"Ritu-śeṣa (balance of a Ritu) is obtained by the sum of balances in all parvas ; at the end of each parva a balance of a half-tithi remains".

The time between two parvas is equal to a "half-lunar month". A Yuga contains 1830 civil days, 120 half-solar months and 124 parvas ; hence, a half-lunar month$=\frac{1830}{124}=14\frac{94}{124}$ civil days and a half-solar month$=\frac{1830}{120}=15\frac{1}{4}=15\frac{31}{124}$ civil days. The balance per parva is, therefore, $15\frac{31}{124}-14\frac{94}{124}=\frac{61}{124}$ civil days=half-tithi. The seasons depend upon solar months ; hence, this is the balance in half-lunar month. This is termed "Adhimāsa śeṣa" in books on astronomy. The balance in 30 lunar months comes to be $\frac{61}{124}\times 60=29\frac{64}{124}$ civil months which is equal to one lunar month. Hence, one month is reckoned as intercalary after every 30 lunar months. The theory about the intercalary month and the meaning of the above verse will thus be clear.

अग्निः प्रजापतिः सोमो रुद्रोऽदितिर्बृहस्पतिः ॥
सर्पाश्च पितरश्चैव भगश्चैवार्यमापि च ॥ २५ ॥

सविता त्वष्टाथ वायुश्चेंद्राग्नी मित्र एव च ॥
इंद्रो निर्ऋतिरापो वै विश्वेदेवास्तथैव च ॥ २६ ॥
विष्णुर्वरुणो वसवोऽजएकपात्तथैव च ॥
अहिर्बुध्न्यस्तथा पूषाश्विनौ यम एव च ॥ २७ ॥

These verses give the names of controlling deities of 27 nakṣatras. The names of nakṣatras are not given, but the order definitely begins from Kṛttikās. The commencing part of 27th verse reads "Viṣṇur-Varuṇo-Vasavo". From this, deities of Śraviṣṭhā and Śatabhiṣak become respectively Varuṇa and Vasu; but the Taittirīya Śruti and all astronomical works give names in reverse order. The Yajurveda-version of this part is "Viṣṇur-Vasavo-Varuṇo"; this must be the correct reading and should be accepted.

The nakṣatras and their deities are as follows :—

Serial number Commencing from Śraviṣṭhā	Serial number Commencing from Kṛttikā	Name	Deity
8	1	Kṛttikā	Agni
9	2	Rohiṇī	Prājāpati
10	3	Mṛgaśīrṣa	Soma
11	4	Ārdrā	Rudra
12	5	Punarvasu	Aditi
13	6	Puṣya	Bṛhaspati
14	7	Āśreṣā	Sarpa
15	8	Maghā	Pitara
16	9	P. Phalgunī	Bhaga
17	10	U. Phalgunī	Aryamā
18	11	Hasta	Savitā
19	12	Citrā	Tvaṣṭā
20	13	Svātī	Vāyu
21	14	Viśākhā	Indrāgnī
22	15	Anurādhā	Mitra
23	16	Jyeṣṭhā	Indra
24	17	Mūla	Nirṛti
25	18	P. Aṣāḍhā	Āpaḥ
26	19	U. Aṣāḍhā	Viśvedeva
27	20	Śravaṇa	Viṣṇu
1	21	Śraviṣṭhā	Vasu
2	22	Śatabhiṣak	Varuṇa

Serial number Commencing from Śrviṣṭhā	Kṛttikā	Name	Deity
3	23	P. Bhādrapadā	Ajaekapāda
4	24	U. Bhādrapadā	Ahirbudhnya
5	25	Revatī	Pūṣā
6	26	Aśvayuj	Aśvinau
7	27	Bharaṇī	Yama

नक्षत्रदेवता एता एताभियज्ञकर्मणि ।। यजमानस्य शास्त्रज्ञैर्नाम नक्षत्रजं स्मृतं ।। २८ ।।

"These are the deities of nakṣatras. The holy preceptors (Śāstrajñas) ordain that the sacrificer should adopt a name based on the nakṣatra (at birth)."

(*Note.*—Other astronomical works give a method by which persons are given names according to the nakṣatra-quarter at birth, and the same is still in vogue).

विषुवं तद्गुणं द्वाभ्यां रूपहीनं तु षड्गुणं ।। यल्लब्धं तानि पर्वाणि तयोर्ध्वं सा तिथिर्भवेत् ।। ३१ ।।

"[.................To find the tithis and parvas elapsed when a certain equinox (after the 1st one) would fall.] Subtract 1 from the number of equinoxes under question. Multiply the remainder by 2 and by 1. Multiply each product by 6. The first product gives the number of parvas elapsed and the second product tithis"

EXAMPLE.—*To find when the 10th equinox would fall.*

Method .—

$10-1=9 \quad 9\times2\times6=108$ parvas

$9\times1\times6=54$ tithis

108 parvas+54 tithis=111 parvas+9 tithis.

Adding to this, period
elapsed for 1st equinox
from the beginning of Yuga, *i.e.*, 6 parvas+3 tithis
=117 parvas+12 tithis

The 10th equinox would, therefore, fall after 117 parvas and 12 tithis would pass, *i.e.* at the end of Kārtika Kṛṣṇa Dvādaśī (12th tithi of dark half of Kārtika) in the 5th year of the Yuga.

The Yajurveda-version for this formula runs thus :—

विषुवंतं द्विरभ्यस्तं रूपोनं षड्गुणीकृतं ।। पक्षा यदर्धं पक्षाणां तिथिः स विषुवान् स्मृतः ।

This verse can directly and easily be rendered as follows :—"Subtract 1 from the equinox-number and multiply the difference by 2. Multiply the result by 6 giving 'pakṣas'. The half of this pakṣa-number would be the tithi at the equinox time."

माघशुक्लप्रवृत्तस्तु पौषकृष्णसमापिनः ।। युगश्च पंच वर्षाणि कालज्ञानं प्रचक्षते ।। ३२ ।।

यजुःपाठ—माघशुक्लप्रपन्नस्य पौषकृष्णसमापिनः ।।

युगस्य पंचवर्षस्य कालज्ञानं प्रचक्षते ।।

Replacing the word 'Pravṛtta' from Ṛk-version by the word 'Prapanna' the Yajur-Jyotiṣa reading would be translated thus:—

"The knowledge of time concerning the 5 year-cycle (yuga) which commences with the light half of Māgha and ends with the dark half of Pauṣa is being described now".

तृतीयां नवमीं चैव पौर्णमासीं त्रयोदशीं । षष्ठीं च विषुवान् प्रोक्तो द्वादश्या च समं भवेत् ॥ ३३ ॥

"The equinox occurs on the 3rd, 9th, 15th, 6th and 12th tithis (and again on these very tithis in the same order)".

It has been shown before, that the equinox day was known in Vedic times. The first equinox occurred 3 solar months after the winter solstice and the second one 6 solar months after the first. According to Vedāṅga Jyotiṣa three solar months are equivalent to 93 tithis; and because the Yuga commenced from the first tithi of Māgha, the first equinox must fall on the 3rd tithi of light half of Vaiśākha. After six solar months, that is after 6 lunar months and 6 tithis, the next equinox must occur. Hence, we get the 9th tithi in the formula. All the equinoxes occurring in a Yuga are given together in a table later on.

The term 'Trayodaśī' is not clear; otherwise, the verse must be translated as above.

चतुर्दशीमुपवसथः तस्तथा भवेद्यथोदितो दिनमुपैति चंद्रमाः
माघशुक्लाह्निको युंक्ते श्रविष्ठायां च वार्षिकीं ॥ ३४ ॥

The verse is understandable if the 9th letter "thaḥ" is omitted.

"The sun and the moon come nearer to one another on the 14th tithi (of dark half). The moon is so positioned that when it rises, the day dawns. It conjuncts with the sun on the 1st tithi of light half of Māgha in the day time and also with the Śraviṣṭhā asterism. Similar is its position (at the end of the first parva) before the commencement of rainy season."

The moon rises when the day has begun, that is, just after sunrise. This is possible on the 1st tithi of light half of Māgha (on the junction of New Moon and 1st tithi). The sun and the moon always conjunct on each New Moon day. The object of mentioning only two New-moon days is that it is only on two occasions during a Yuga that the Udagayana or Dakṣiṇāyana commence on New-moon days, the first one being the Uttarāyaṇa on the commencing tithi of Māgha in the beginning of the first year and the second one being the Dakṣiṇāyana in the beginning of Srāvaṇa in the third year.

(2) YAJURVEDA JYOTIṢA

एकांतरेह्नि मास च पूर्वाहृत्वादिरुत्तरः ॥ ११ ॥

"The later Ṛtu commences after every alternate day and alternate month from the former Ṛtu."

Two solar months make a season; and the dates of commencement of these seasons during five years are given in a table later on. It will be seen that the term 'Ekāntarenhi' (*i.e.* alternatively) applies to tithis.

एकादशभिरभ्यस्य पर्वाणि नवभिस्तिथिं । युगलब्धं सपर्वं स्यात् वर्तमानार्कभं क्रमात् ॥ २५ ॥

"Multiply the number of parvas elapsed by 11; add to this the product of number of tithis by 9. Divide the sum by 124, and add the parva-number to the quotient, which gives the solar nakṣatra (on the desired tithi)".

Because a yuga contains 124 parvas, the word yuga has been used to mean 124 in this verse. A nakṣatra is supposed to be divided into 124 parts. Some other verses also lead one to the same view. The sun crosses such 9 parts during one tithi.

Example:—(i) *To find the solar nakṣatra at the end of Full-moon in the month of Māgha in the 1st year of the cycle.* Solution:—(Tithis) *i.e.* $15\times9=135$. $\frac{135}{124}=1+\frac{11}{124}$ Here the quotient is 1 and the parva number elapsed is zero. The sun has therefore crossed 11 parts of the 2nd nakṣatra.

(ii) *To find the solar nakṣatra at the end of 3rd parva.* Because three parvas have elapsed, $3\times11\div124+3=3\frac{33}{124}$. This shows that the sun has crossed 33 parts of the fourth nakṣatra.

त्रिंशत्यन्हां सषट् षष्टिरब्दः षड् ऋतवोयने । मासा द्वादश सूर्याः स्युरेतत्पंचगुणं युगं ॥२७॥

"There are 366 days, 6 seasons, 2 ayanas (and) 12 solar months in a year. A yuga is five times such."

उदया वासवस्य स्युर्दिनराशिः स्वपंचकः । ऋषद्विंषष्टिहीनं स्याद्विंशत्या चैकया स्तृणां ॥ २८ ॥

"The sun (Vāsava) rises five times the number of days in a year of the yuga (*i.e.* 1830). The moonrises (Ṛṣi) are 62 less."

A civil day is the time between two consecutive sunrises. Hence the number of civil days in a year is equal to number of sunrises during the period. Hence, 5 times the number of civil days (366) is the number of sunrises. If the sun would have been a fixed body like other stars, the number of sunrises would have been equal to those of the stars; but because it moves through the stars a short distance towards East every day, it rises a little later than the star with which it had conjuncted the previous day. Thus, it makes a complete revolution through the stars; and it is, therefore, obvious that the number of rises of a star is 367, *i.e.* more than 366 by one, in one year, and hence they are 5 more than those of the sun in one Yuga. The moon revolves through the asterisms 67 times in one yuga (*See* verse 31, below); hence, the number of moonrises is less than those of stars by 67 and less than sunrises by 62 in one yuga. The fourth quarter of the verse is illegible. It appears, they must have originally contained words meaning something like 'the number of stellar-rises is greater than sunrises by five'.

पंचत्रिंशच्छतं पौष्णमेकोनमयनान्यृषेः । पर्वणां स्याश्चतुष्पादी काष्ठानां चैव ताः कलाः ॥ ३०॥

"(In one yuga) the lunar ayanas occur 134 times and lunar parvas 124. One kalā is equivalent to 124 kāṣṭhā."

The word "Pauṣṇaṃ" in the original verse does not appear to fit in; but looking to the general sense, any other word is not possible. The moon revolves 67 times during a yuga; hence, $67\times2=134$ must be the number of 'lunar ayanas'. The word 'pāda' indicates the number 31 according to verse 12 ; hence, "chatuṣpadī" would stand for 124.

सावनेंदुस्तृमासानां षष्टिः सैकाद्विसप्तिका । द्युत्रिंशत् सावनः सार्धः सूर्यः स्तृणां सपर्ययः ॥ ३१ ॥

"A yuga consists of 61 civil months, 62 lunar months and 67 sidereal months. One civil month consists of 30 days, and the solar month of $30\frac{1}{2}$ days. The sidereal month is the time taken by the moon to make a complete revolution through the asterisms."

One year consists of 12 solar months (*See* Yajur-version 28) hence, one yuga contains 60 solar months and 1830 civil days.

Hence, one civil month=1830 civil days÷61 civil months=30 days. Similarly, a solar month=$\frac{1830}{60}=30\frac{1}{2}$ days.

उग्राण्यार्द्रा च चित्रा च विशाखा श्रवणाश्वयुक् ॥ क्रूराणि तु मघा स्वाती ज्येष्ठा मूलं यमस्य यत् ॥ ३३ ॥

"The stars, Ārdrā, Citrā, Viśākhā, Śravaṇa and Aṣvayuj are awe-inspiring (Ugra) while Maghā, Svātī, Jyeṣṭhā, Mūla and that of Yama (*i.e.* Bharaṇī) are of cruel nature."

Our present-day books on 'Muhūrta' take the awe-inspiring stars as cruel also, but they include only Maghā and Bharaṇī. According to them Ārdrā, Jyeṣṭhā and Mūla are horrifying or sharp-natured stars ; but these can also be regarded as cruel-natured. Of the remaining stars, Citrā is at present regarded as soft-natured, Viśākhā as having a mixed nature, Śravaṇa and Svātī as having varying (Cala) nature and Aṣvinī as stars of trifling importance.

ऊनं द्विषष्टिभागेन हेयं सूर्यात् सपार्वणं । यत्कृतावुपजायेते मध्ये चांते चाधिमासकौ ॥ ३७ ॥

This can be rendered as "when the 62nd part of a civil day is subtracted from it we get a lunar day (or tithi) and if 60th part be added to it we get a solar day; because of this (*viz.* that the lunar day is shorter than the solar day) the intercalary month comes in the middle and at the end of a yuga".*

Somākara has given some quotations from Garga; his commentary describes completely the 5-year-yuga system of Vedāṅga Jyotiṣa. He has introduced a new time unit — 'Lava' — which is a part of a day. This helps an easy understanding of the Garga-quotations.

सावनं चापि सौरं च चान्द्रं नाक्षत्रमेव च ।
चत्वार्येतानि मानानियैर्युगं प्रविभज्यते ॥ १ ॥
अहोरात्रात्मकं लौक्यं मानं च सावनं स्मृतम् ।
अतश्चैतानि मानानि प्राकृतानीह सावनांत् ॥ २ ॥
ततः सिद्धान्यहोरात्राण्युदयाश्चाप्यथार्कजाः ।
त्रिंशच्चाष्टादशशतं (१८३०) दिनानां च युगं स्मृतम् ॥ ३ ॥
मासस्त्रिंशदहोरात्रः पक्षोर्धं सावनं स्मृतम् ।
अहोरात्रं लवानां तु चतुर्विंशशतात्मकम् (१२४) ॥ ४ ॥
सौर्यं तु सूर्यसंभूतं परिसर्पति भास्करे ।
यावता त्व्युत्तरां काष्ठां गत्वा गच्छति दक्षिणाम् ॥ ५ ॥
कालेन सोब्दस्तस्यार्द्धमयनं तु त्रयोर्तवः ।
ऋतोरर्द्धं भवेन्मासस्त्रिंशद्भागं दिनोत्कंजः ॥ ६ ॥

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* No. of civil days in a yuga=1830

No. of lunar months in a yuga=62

Therefore, 1 tithi=$\frac{1830}{62\times30}$civil days=$\frac{61}{62}$ civil days=$1-\frac{1}{62}$ civil days.

1 solar month = $30\frac{1}{2}$ civil days.

Therefore, 1 solar day=$\frac{30}{30}$ civil days=$\frac{61}{60}$civil days=$1+\frac{1}{60}$civil days.

तस्यार्द्धमर्कजः पक्षस्तस्मात्पंचदशं दिनं ।

शतं लवानां षड्विंशं (१२६) लवाः पंचदश ($\frac{१}{१५}$) स्तथा ।। ७ ।।

* त्रिंशच्चाष्टादशशतं (१८३०) युगमार्कैंदिनैः स्मृतम् ।
वृद्धिक्षयाभ्यां संभूतं चान्द्रं मानं हि चन्द्रतः ।। ८ ।।
लवं लवमथोनेन सावनेन निशाकरः ।
क्षयवृद्धिमवाप्नोति स चान्द्रो मास उच्यते ।। ९ ।।
तस्यार्द्धं पार्वणः पक्षस्तस्मात्पंचदशी तिथिः ।
प्रमाणेन लवानां तु द्वाविंशं शत (१२२) मूच्यते ।। १० ।।
सोमस्याष्टादशशती युगे षष्ठ्यधिका (१८६०) स्मृता ।
यावतात्वेव कालेन भवर्गं त्रिणवात्मकम् ।। ११ ।।
भुंक्तेचन्द्रः स आक्षों मासस्तस्यार्द्धं पक्ष उच्यते ।
आक्षात् पक्षात् पंचदशं नाक्षत्रं दिनमुच्यते ।। १२ ।।
प्रमाणेन लवानां तु द्वादशं शत (१२२) मुच्यते ।

षष्ट्या तु सप्तषष्ट्यंशे ($\frac{६०}{६७}$) नाधिकोऽस्मिन् परोलवः ।। १३ ।।

दशोत्तरैर्द्विसहस्रै (२०१०) युंगमाक्षैंदिनैः स्मृतम् ।

STUDY OF ṚG-YAJUR-VEDĀṄGA-JYOTIṢA

The Composition period

Let us now consider the problem of the "time of Vedāṅga Jyotiṣa". It has been told in the 6th verse of Ṛg-Jyotiṣa that the winter solstice commences from the beginning of Śraviṣṭhā and the summer solstice from the middle of Āśreṣā. At present the sun turns towards north when the sun and the moon conjoin near the Purvāṣāḍhā constellation. The solsticial point is thus seen to be gradually receding. This phenomenon is termed "*Ayana Calana*". The equinoctial motion is very accurately known in our time and with its help can be found the time when the luni-solar phenomena described in Vedāṅga Jyotiṣa had occurred.

European scholars like Colebrooke have found out the time of Vedāṅga Jyotiṣa, basing their calculations on the assumption that in those times the sun and the moon conjuncted on the winter solstice day with the beginning point of the Dhaniṣṭhā division, the zodiacal divisions being supposed to begin from the Revatī star. It amounts to supposing the Alpha-Delphini star as the beginning point of Dhaniṣṭhā division, which is not the case, the fact being that the star Alpha is in advance of the beginning point by 4° 11′; and hence, the time calculated by them is mistaken by an amount of time (*viz.* 300 years) which is necessary for the equinoctial point to recede by 4° 11′. What does the statement "winter solstice began at the beginning of Dhaniṣṭhās" mean? How can we say that the winter solstice commenced when the sun and the moon come near that imaginary point which is the beginning of an imaginary Dhaniṣṭhā division? And it is a fact that the beginning point of the Dhaniṣṭhā division (which is one of the nakṣatra divisions belonging to Aśvinyādi system) is an imaginary point.

* There is some misprint in the reading. It ought to give 1800 as the meaning.

The next important point to remember is that, whatever be the period of composition of Vedāṅga Jyotiṣa, the fact remains that the Aśvinyādi system of nakṣatra division had not come into vogue and hence, the beginning point of Dhaniṣṭhā division belonging to this system was also unknown. The mathematicians will, therefore, agree that the time calculated on the assumption of the sun and the moon's coincidence with this beginning point of Dhaniṣṭhā as the moment of Udagayana, was no doubt mistaken.

The verses should clearly be taken to mean that the Uttarāyaṇa commenced when the sun and the moon came near the cluster of 4 or 5 visible stars. At the moment of winter solstice, the tropical longitudes of both the sun and the moon must be 270° or 9 rāśis; and because it took place at the beginning of Dhaniṣṭhā, it is evident that the longitude of Dhaniṣṭhā also used to be 9 rāśis. Keropant regarded Alpha-Delphini as the junction star of Dhaniṣṭhā ; Colebrooke also regards the same. The author has calculated the tropical longitude of this star in 1887 A.D. as being 10^{s} 15° 48′ 29″ *i.e.*, in excess over 270° by 45°-48′. Taking 50″ as annual precessional motion of equinoxes, the time for this excess comes to be 3297 years. Subtracting this figure from 1887, we get 1410 B.C. as the year when the longitude of Dhaniṣṭhā could be 9 signs *i.e.* when the winter solstice used to take place near the Dhaniṣṭhā stars. This comes to be the time of Vedāṅga Jyotiṣa. If we regard Beta-Delphini as the junction-star as supposed by Prof. Whitney, the time would prove to be 72 years earlier, and since all the stars in this asterism lie within a degree, the time of the 'Jyotiṣa work' will not much vary. On an average 1400 B.C. should be regarded as the time. Colebrooke and others calculate the time as follows:—

The equinox used to occur near the Zeta-Piscium star near about the year 572 A.D. In those days the winter solstice used to take place at the end of the first quarter of the Uttarāṣāḍhā nakṣatra division instead of in the beginning of Dhaniṣṭhā, as described by Vedāṅga Jyotiṣa. A shifting of $1\frac{3}{4}$ nakṣatras *i.e.* 23° 20′ had then taken place. The time for this shift at the rate of 50″ per year comes to be 1680 years. Hence, the winter solstice used to occur near the beginning of Dhaniṣṭhās about the year (1680-572) or 1108 B.C. The figure is shorter by 300 years because of the supposition that Udagayana used to take place "in the beginning of the Dhaniṣṭhā division". It has already been pointed out above that the time should be calculated on the basis that winter soltice took place near a star of Delphini group.*

The time of composition of Vedāṅga Jyotiṣa as astronomically calculated by the author is quite correct beyond doubt; but some European scholars on philological grounds, believe it to be "not so old". They attempt to bring the times of our ancient works as later as possible. Max Muller writes that it was composed in the 3rd century B.C. Prof. Weber even suspects it to have been written in the 5th century A.D. Let us, therefore, examine this point more critically.

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*The precessional motion is gradually increasing at a very slow rate. It might have been a bit smaller than 50″ in 1400 B.C. Taking 48″ as the motion, the above calculated time would come to be smaller by about 135 years. The time calculated by Colebrooke and others differs from the one viz. 1108 B.C. etc. calculated by me because of the assumption of different precessional motions and of different years for the conjunction of equinoctial point with the Zeta-Piscium star.

Varāhamihira says:—

आश्रेषार्द्धांद्दक्षिणमुत्तरमयनं रवेर्धनिष्ठाद्यं ।। नूनं कदाचिदासीद्येनोक्तं पूर्वशास्त्रेषु ।। १ ।।
सांप्रतमयनं सवितुः कर्कटकाद्यं मृगादितश्चान्यत् ।। उक्ताभावो विकृतिः
प्रत्यक्षपरीक्षणैर्व्यक्तिः ।। २ ।।

बृ० सं० अध्याय ३

आश्रेषार्द्धादासीद्यदा निवृत्तिः किलोष्णकिरणस्य ।।
युक्तमयनं तदासीत् सांप्रतमयनं पुनर्वसुतः ।।

पंचसिद्धांतिका

After describing the astronomical positions of the sun at the commencements of Ayanas (Solstices) in the times of Vedāṅga Jyotiṣa , he remarks "as told in ancient Śāstras". The whole trend of the description shows that in his time (near about Śaka year 427) the Vedāṅga Jyotiṣa had come to be regarded as "very old". He has, in his Pitāmaha Siddhānta (which was a part of Pañca Siddhāntikā) given some mathematical formulae, which had been out of use in his time as being very old; and the author has shown in 'Part Two', that the formulae resembled with those given by Vedāṅga Jyotiṣa.

Brahmagupta says,

ब्रह्मोक्तं ग्रहगणितं महता कालेन यत् खिलीभूतं ।।

ब्रह्मसिद्धां० अ० १ आर्या २.

This shows that at the time of Brahmagupta and Varāhamihira the Pitāmaha Siddhānta was being regarded as having been written very many years ago.

A good many quotations from Garga have been given before; it appears that Vedāṅga Jyotiṣa occupied an important place in his time. Even Parāśara says:—

श्रविष्ठाद्यात्पौष्णार्घं चरतः शिशिरो वसंतः ।।

बृ० सं० ३. १ भटोत्पलटीका.

This gives the same solar position for winter solstice as given by Vedāṅga Jyotiṣa. This shows that it must have been composed long before these two seers lived. Although the Saṃhitās composed by Garga and Parāśara do describe the Vedāṅga Jyotiṣa, the circumstances for a winter solstice to occur at the commencement of Dhaniṣṭhā had no doubt altered. While commenting on the portion 'Aprāptamakara' in Chapter 3, Bṛh. Saṃ., Bhaṭotpala has quoted the following verse:—

यदा निवर्ततेऽप्राप्तः श्रविष्ठामुत्तरायणे ।। आश्लेषां दक्षिणेऽप्राप्तस्तदा विंद्यान्महद्भयं ।।

गर्ग.

Parāśara's verse also has been quoted above. These verses show that Vedāṅga Jyotiṣa was composed long before the times of Garga and Parāśara; but it is very difficult to fix up their times. Garga has been a very famous astrologer in India (*See* Gadāparva, Chap. 8, verses 14 and 15). The name of Garga has occurred a number of times in Pātanjal-Mahābhāṣya; and one comes across the names of Parāśara and Garga even in Pāṇinī (*See* 4-3-110, 4-10-105, etc.). The two, therefore, must have lived before Pāṇinī and Vedāṅga Jyotiṣa was composed long before them. According to Dr. Bhandarkar,

Pāṇinī's time comes to be the beginning of 7th century B.C. and according to late V. Kunte it was the beginning of 9th century B.C. The words "Samvatsara, Parivatsara etc." occur in Pāṇinī (*See* 5-1-92) and the measures of Āḍhaka and Khārī etc., as described by Vedāṅga Jyotiṣa were in use in Pāṇini's time (*See* 5-1-53). These support the view that Vedāṅga Jyotiṣa existed long before Pāṇinī. Another important consideration leads one to believe that it was composed in those times when the Vedic methods of performing sacrifices were well known and perfectly set up in society, as can be seen from the fact that Vedāṇga Jyotiṣa has specially described the method of calculating the "Viṣuvān" day correctly, this day being regarded as the most important one by Aitareya and Taittirīya Brāhmaṇa. Now, although some philological evidences like the words "*Yathā Śikhā Mayūrāṇāṃ*" might appear to be modern, it can not be said so about all other verses. Dr. Martin Haug says (in his lecture on the Vedas) "the word 'Gharma' has been used by Vedāṅga Jyotiṣa to mean a 'day'. (*See* verse 7 Ṛk-reading). The use of the word in this sense had become out of use long before Yāska who lived before Pāṇinī.

The Vedāṅga Jyotiṣa must, therefore, have been written near about the times of composition of 'Śrauta and Smārta sūtras' *i. e.* between 1200 and 600 B. C. There are no evidences of the nature of astronomical terms, that Vedāṅga Jyotiṣa belonged to an earlier period. It used a terminology different from the one in which number are indicated by words, *e.g.* the number 'four' is denoted by the word Veda. Prof. Weber says that the names of nakṣatras given by Vedāṅga Jyotiṣa are like those found in modern books and that it contains Rāśi-names also. The author has already translated the verse in which the term Rāśi occurs. He maintains that not only Vedāṅga Jyotiṣa does not give Rāśi-names, but also it does not give nakṣatra-names which are current in modern times. Of the list of nakṣatras, the Ṛk-version clearly gives the name of only one star, and that too as Śraviṣṭhā and not as Dhaniṣṭhā of the modern times. The verse No. 36 of Yajurveda version gives names of 9 stars, and the list gives Aśvayuk as the ancient name and not as Aśvinī for one of them, while others are modern names. Similarly, verse No. 14 of Ṛk-version gives a list of symbolic names of stars which can help one in differentiating ancient names from modern ones, *e.g.* Aśvayuk and Śatabhiṣak which are ancient names. It no doubt contains a name, Śravaṇa, which appears to be modern, yet it is not similar to the name "Śroṇā" of the Taittirīya Brāhmaṇa. The star used to be called as Śravaṇa even in the times of Atharva Saṃhitā (*See* pp. 47-48) and of Pāṇinī (*see* Pāṇinī, 4. 2.5; 4.2.23). Prof. Weber's arguments do not, therefore, deserve consideration. All the above considerations will support the author's view that we must accept that time for the composition of Vedāṇga Jyotiṣa which one gets on grounds of astronomical calculation.

The Place of Composition.

Let us attempt to find out the place of its composition on the basis of statements about length of the day as given by Vedāṇga Jyotiṣa. The verse No. 7 & 22 (Ṛk-version) say that the daily increase in the length of day is /61 nāḍīs and that the lengths on solsticial days are 24 and 36 ghaṭis respectively. The "Dinārdha" *i.e.* length of half-day comes to be respectively 12 and 18 ghaṭis, and the correction for ascensional difference is 3 ghaṭis. The sun acquires maximum declination on the two occasions. The value of Sun's maximum declination about the year 1400 B.C. used to be 23° 53′*. Our

*See pages 48-50 of planetary tables by Keropant.

astronomical works give it to be 24°. Let us try to find by the following method the stations where both the values can be true:—

Formula:—Sin (A.D.)×cot (declin) = tan (lat. of place). Here, A.D.= 3 ghaṭis=18°.

	(i)	(ii)
	L sin 18°=9.489982	L sin 18°=9.489982
	L cot 24°=10.351417	L cot 23° 53′ =10.353801
Therefore	L tan (lat.)=9.841399	∴ L tan (lat.)=9.843783
,,	latitude=34° 45′.8	∴ latitude=34° 54′

This shows that the place of composition must be a place whose latitude is either 34° 46′ or 34° 55′. The work gives 4/61 nāḍi as the daily increase in length. The fact is that the increase is never constant. It is minimum when the sun goes to solstices and is maximum when it comes to equinoxes. At a place on latitude 35°, the increase in length of day would be found to be only 1/61 ghaṭi (at the most) in two days near about solsticial days and about $5\frac{1}{2}/61$ ghaṭis per day on or about equinoxial days.

Ayana Calana (Shifting of Equinoxes)

The Vedāṅga Jyotiṣa mentions the commencement of a Yuga as coincident with that of the winter solstice and also that of Dhaniṣṭhā. It is clear from this that they had no idea of shifting of equinoxes in those times.

Detailed information about length of a year etc. in the Vedāṅga Jyotiṣa Period

Number in a Yuga	No. of days in a year	Dates of equinoxes	Dates of commencement of seasons	Omitted (Kṣaya) Tithis
(1) Solar months 60 (2) Lunar months. 62	Samvatsara 355	(i) Vaiśākha S. 3 (ii) Kārtika S. 9	Māgha S. 1 Caitra S. 3 Jyeṣṭha S. 5 Śrāvaṇa S. 7 Āśvina S. 9 Mārgaśīrṣa S. 11	Caitra S. 2 Jyeṣṭha S. 4 Śrāvaṇa S. 6 Āśvina S. 8 Mārgaśīrṣa S 10
(3) Intercalary months 2 (4) Civil days 1830 (5) Tithis 1860	Parivatsara 354	(i) Vaiśākha S. 15 (ii) Kārtika K. 6	Māgha S. 13 Caitra S. 15 Jyeṣṭha K. 2 Śrāvaṇa K. 4 Āśvina K. 6 Mārgaśīrṣa K. 8	Māgha S. 12 Caitra S. 14 Jyeṣṭha K. 1 Śrāvaṇa K. 3 Āśvina K. 5 Mārgaśīrṣa K. 7
(6) Kṣaya tithis. 30 (7) Sidereal months. 67 (8) Nakṣatras 1809 (9) Vṛddhi nakṣatras 21	Idāvatsara 384	(i) Vaiśākha K. 12 (ii) Kārtika S. 3	Māgha K. 10 Caitra K. 12 Jyeṣṭha K. 14 Śrāvaṇa S. 1 Āśvina S. 3 Mārgaśīrṣa S. 5	Māgha K. 9 Caitra K. 11 Jyeṣṭha K. 13 Adhika Śrāvaṇa K. 30 Āśvina S. 2 Mārgaśīrṣa S. 4

	Anuvatsara 354	(i) Vaiśākha S. 9 (ii) Kārtika S. 15	Māgha S. 7 Caitra S. 9 Jyeṣṭha S. 11 Śrāvaṇa S. 13 Āśvina S. 15 Mārgaśīrṣa K. 2	Māgha S. 6 Caitra S. 8 Jyeṣṭha S. 10 Śrāvaṇa S. 12 Āśvina S.14 Mārgaśīrṣa K. 1
	Idvatsara 383	(i) Vaiśākha K. 6 (ii) Kārtika K. 12	Māgha K. 4 Caitra K. 6 Jyeṣṭha K. 8 Śrāvaṇa K 10 Āśvina K. 12 Mārgaśīrṣa K. 14	Māgha K. 3 Caitra K. 5 Jyeṣṭha K. 7 Śrāvaṇa K. 9 Āśvina K. 11 Mārgaśīrṣa K. 13 Adhika Māgha K. 30
Total	1830	10	30	30

The dates on which the ayanas in a Yuga begin are already given on p. 71. The dates of commencement of seasons are given in the above table. It should be noted that (i) between each pair of these dates, one more solar month falls. These two lists together would give 60 dates of month-beginnings. (ii) The first intercalary month is inserted between Āṣāḍha and Śrāvaṇa of the 3rd year (after 30 lunar months have elapsed after Yugādi), and the second is inserted after 30 more lunar months elapse, that is, after Pauṣa of the 5th year. Thus Śrāvaṇa and Māgha always happen to be intercalary months in each Yuga. (iii) Because one yuga consists of 1830 civil days and 1860 tithis, the number of 'Lapsed tithis' comes out to be 30. (iv) Similarly, because the moon revolves 67 times during the period, the number of nakṣatras through which it passes would be $67 \times 27 = 1809$ and hence, in 1830 civil days the increase in their number becomes 21. The nakṣatra cycle begins from Śraviṣṭhās (*See* verses 25 to 27, Ṛk-version). Under Vedāṅga Jyotiṣa system the moon and the sun are supposed to move by a uniform motion, which is termed as "mean motion" in astronomical works; and because a mean tithi is shorter than a mean civil day, a tithi-vṛddhi can never occur; so also a "lapsed nakṣatra" can never occur because the mean length of a nakṣatra is greater than a civil day.

The Pañcāṅga

The above discussion will make it clear that once a 5-yearly calendar is compiled, it would serve the purpose for all yugas to come. The detailed panchang can not be given here for its being very extensive; its salient features are, of course, described above.

Let us now examine the correctness of the lengths of the year and of other units of time.

	Vedāṅga Jyotiṣa	Sūrya Siddhānta	Modern European
Number of civil days in a yuga.	1830	1826.2938	1826.2819 (Sidereal)
No. of days in 62 lunar months	1830	1830.8961	1830.8964
No. of civil days in 95 years	34770	34699.58	34699.36 (Sidereal Yr.) 34698.03* (Tropical Yr.)
No. of days in 1178 lunar months	34770	34787.03	34787.03

This shows that while the error in the measure of a lunar month is very small, that in the solar year is big**. The result is that if the first 'ayana' would take place on a Māgha Śukla 1 of a certain Yuga, it will not take place on the same tithi of the next yuga but 4 days earlier; similarly, after 95 years it will take place some 72 days earlier and so on. The error in the measure of a lunar month is very small; yet, because the cumulative error would amount to 54 ghaṭis in 5 years, there will be an error of about one day in 5 years, even if we reckon full moons and new moons according to the Vedāṅga Jyotiṣa system. But, although the error in the case of ayanas is not easily detectable, that in the case of Pūrṇimā and Amāvāsyā can be readily found. From this, it seems that they must have taken 1830 as the round figure for the number of civil days in a yuga, while reckoned by actual observations of the positions of the moon on full-moon days, it must have been coming to about 1831 days; and because the number of lunar months in 95 years (including 38 intercalary months) being taken to be 1178, the number of civil days in 19 yugas or 95 years would actually come to be 34787 or (according to Vedāṅga Jyotiṣa) 34770, and the next Māgha Śukla 1 would again be so after 95 years and would be the first tithi of the 96th year. But the fact remains that 95 solar years would consist of 34698 days, which shows that the winter solstice (coming in the 96th year) would fall 89 days (or at least 72 days) earlier than the Māgha S. 1. of that year, which amounts to a difference of 2½ to 3 lunar months. To avoid this the number of intercalary months should not be taken as 38 (as per Vedāṅga Jyotiṣa system), but only 35; otherwise a difference of 3 seasons would occur in 200 years. This is too much to be neglected.

*This is calculated from the length of a solar year in 1400 B. C.

**Shri Visaji Raghunath Lele observes that the measure of the length of the solar year is gradually and slowly decreasing and the European scholars also maintain the same view. It is, therefore, probable that Vedāṅga Jyotiṣa was composed in a period in the previous cycle of equinoxes *i. e.* 28000 years ago, when the length of a year might have been actually 366 days.

Such a wrong system could not have remained in vogue all over the country for a long time; and we can not but believe that the Vedāṅga Jyòtiṣa system was not in practice for a very long time. The intercalary months, decayed tithis and excess nakṣatras recur in the same order and these things have much religious importance. The intercalary month is regarded as 'Censurable' even in the Vedas. If, therefore, the Vedāṅga Jyotiṣa system had been in use in all provinces and for a long time we would have come across their references in 'Sūtra' works. This shows that it must have remained in use, if at all, in only some provinces. The rate of increase in the length of day (as given by Vedāṅga Jyotiṣa) is applicable only to a place on latitude 34° N. But this does not in any manner stand in the way of our supposing 1400 B.C. as the probable date of that work. The Taittirīya Śruti gives 4 names for the years, sometimes 5 or even 6. The reason for this, the author believes, must be that the '5-year-cycle' system of Vedāṅga Jyotiṣa did not come into vogue fully then. It was perhaps found that the 'ayanas' repeat with respect to lunar months in a cycle of 5 years, and this must have led them to adopt either 4 years or 6 years for the cycle. It may be that there might not have been any fixed cycle in use and then the author of Vedāṅga Jyotiṣa might have calculated 366 days as the average length of a year and introduced a fixed system of a 5-year-cycle. It is even probable that people must have either discarded the system as wrong or allowed it to continue, adjusting the insertion of intercalary months in their proper place, *viz.* 35 in place of 38 during a period of 95 years. Almost all our religious rites are performed on the proper lunar positions since time immemorial, and they have found it convenient to adjust the calculation to a correct solar time by adjusting the insertion of intercalary months. The author has already observed in Section 1 that in his opinion, this was the system in vogue even in the Vedic times. It requires 1000 years to pass for changing the position of winter solstice with respect to a nakṣatra; and they could have controlled the occurrence of winter solstice in Dhaniṣṭhā in the beginning of Maghā and retention of 5 names for the 5 years, by careful adjustment of intercalary months in their proper place, and could have continued the system for some centuries. In short, it can be said that, even if the Vedāṅga Jyotiṣa system would have been out of use in its original form, it must have continued in some other form and that is why we get references about it in astronomical works by Garga and others. It will be shown in a discussion in Part Two, that the Jovian sixty-year cycle owed its origin to this "5 year-cycle" system. That this system has got a place in the list of Vedāṅgas (parts of the Vedas) is itself something very important. It can not be said for certain as to when it obtained that elevated position, but the author believes that it must have received that importance within 200 years of its origin, *i.e.* before the time when it was found useless in its original form for religious purposes. Varāhamihira does not call it a 'Vedāṅga', but it was definitely so at his time. Brahmagupta (Śaka 550) at one place says:—

युगमाहुः पंचाब्दं रविशशिनोः संहितांगकारा ये ॥
अधिमासावमरात्रस्फुटतिथ्यज्ञानतस्तदसत् ॥ २ ॥

ब्र० सि० अ० ११

The word 'Aṅga' occurring in this appears to be used to denote Vedāṅga Jyotiṣa. At present it is regarded a part of the Vedas (Vedāṅga).

Apapāṭha (Deformed Readings)

It can not be said for certain as to when the incorrectness entered in the readings of Ṛg-Jyotiṣa; but the quotation of Varāha *viz.* "Pañcāśatpala-

māḍhakaṃ" and that of Bhaṭotpala *viz.* "Caturbhirāḍhakairdroṇaḥ" show that these did not enter till Śaka 427 and 888 respectively. Bhaṭotpala has taken latter half of verse No. 32 (Ṛk-reading) in his commentary on the penultimate verse of chapter 8 of Bṛhat Saṃhitā. The author finds the same in a manuscript copy of the book in his possession. It runs thus,

युगस्य पंचमस्येह कालज्ञानं निबोधत ॥

Here the word 'Pañcamasya' seems to be a misprint. It ought to be "Pañcavarṣasya". Similarly, the Vaidikas read "Pracakṣate" in place of "Nibodhata". Hence, if 'Nibodhata' be the original reading by Bhaṭotpala, it can be said for certain that the incorrectness did not enter into the readings till Śaka 888; still, this conjecture can not be said to be a final word on it for want of further evidences.

Pradhāna Pāṭha (The Principal Readings)

The 24th verse of Yajur-Jyotiṣa is similar in meaning to, but different in words from, the 17th verse of Ṛk-version and quoted by Varāhamihira and Bhaṭotpala.

This shows that the Vaidic Brahmins in the times of Varāhamihira and Bhaṭotpala used to recite the Ṛk-reading (and not the Yajur one) in its correct form; it can be said that the people at least paid greater importance to the Rigveda-reading. The commentator of Āryabhaṭīya, named Sūryadevayajvan has taken two verses* from Vedāṅga Jyotiṣa in his commentary. These happen to be the last two verses, *viz.* 35th & 36th of the Rigveda-version and are given in this very order, and not in the order of Yajurveda-version—there they stand respectively 4th and 3rd—and looking to the context of the commentary it seems that the taking of first or last verses at that place was quite reasonable. This shows that even at the time of Sūrya Deva, the Ṛk-reading was considered as more important. The time of Sūryadevayajvan is not known, but he appears to have lived later than Bhaṭotpala.

In the latter half of 35th verse (*See* Sūryadeva's commentary) is found the word "Tathā" in place of "Tadvat". The word 'Tathā' is not found in any of the two Vedic-Jyotiṣa works. If, therefore, the word is Sūryadeva's replacement, it seems that the current Vaidic reading did not come in use in final form at least in his province.

It cannot be said for certain, if the Yajurveda reading was at all known to Varāhamihira, Bhaṭotpala and Sūryadevayajvan; but the Yajur-reading also appears to be an ancient one; because only six verses from Ṛk-version are not found in it, and of these six only three important ones *viz.* 13th, 19th, 33rd are missing. It contains 13 verses more than Ṛg-Jyotiṣa. These can definitely be seen to belong to the period when Vedāṅga-Jyotiṣa was in vogue and might have been composed by Lagadha himself. Also, the list of cruel and horrifying nakṣatras given in the 36th verse of Yajur-Jyotiṣa does not tally with that given by other astronomical works.

This shows that the Yajur-Jyotiṣa belonged to a comparatively later period. But the 24th verse is quite different in words and the 21st is partially different from similar verses in Ṛg-Jyotiṣa, and those of the verses (from both the works) which are illegible, some may be similar and others might be opposite in meaning. This leads one to believe that some verses not composed by Lagadha were later on interpolated in the Yajur-Jyotiṣa. The sequence of verses in

*See "Introduction to Āryabhaṭīya" by Dr. Kern.

both the readings is not logical; if an attempt be made to re-write them in the logical order of topics, the order of verses will change much; and this shows that the present order of verses is a result of an attempt at composition by a later writer and in so doing, some of the original verses must have been lost for ever. For instance, the units of Kāṣṭhā and Akṣara have been mentioned in the same verse, although they bear no relation to other units and they are not seen to have been used anywhere in the text; but the words could not have come in without any reason. These support the author's belief that some original verses must have been lost.

Planetary motions.

Vedāṅga Jyotiṣa has given the motions of the Sun and the Moon only. It mentions nothing about other planets. Although some verses are found illegible, the author can say for certain that they do not give any other important information.

Mean motions of planets

The motions of the Sun and the Moon as given by Vedāṅga Jyotiṣa are mean motions, but since these motions change every moment, the sun's true place differs from the mean place by about 2 degrees* and that of the moon by about 8 degrees. It cannot be said for certain if they in Vedāṅga Jyotiṣa's time knew how to calculate the difference between true and mean place of a planet, the term now being known to us as "Equation of centre". Brahmagupta, however, remarks in his couplet given on page 93 that astronomers of these times did not have any knowledge of planets' true places.

One will not be able to detect the difference between the true and mean motions and positions of the sun and the moon unless one observes their places and motions regularly and studies them. This difference would come to one's notice at the time of eclipses if one knew that eclipses take place near the ending moments of Full Moon or New Moon. It is nevertheless a matter of pride to us that they in Vedāṅga Jyotiṣa's time had at least the knowledge of sun's and moon's motions, if not of their true places. The daily mean motion and the time for their complete revolution can not be found unless one actually records and calculates the time that the sun and the moon take in a finite number of revolutions, and it is clear that people had obtained this much knowledge before the compilation of Vedāṅga Jyotiṣa. The measure of a solar year appears to have been mistaken because of the fact that the nakṣatras near about the sun are never visible.

The adoption of mean motions (to the sun and the moon) by Vedāṅga Jyotiṣa brought the solstices and equinoxes at the distance of 183 days from one another and the distance of one solstice from the next equinox comes to be $91\frac{1}{2}$ days. But their actual relative distances before the year 1400 B.C. used to be as given below :—

	Distance	Days	Ghaṭis
From	Winter Solstice to Vernal Equinox	91	5
,,	Vernal Equinox to Summer Solstice	94	5
,,	Summer Solstice to Autumnal Equinox . .	91	30
,,	Autumnal Equinox to Winter Solstice . . .	88	35
		365	15

* One degree being 360th part of a full circular measure.

The Year

The words 'Varṣa' and 'Saṃvatsara' are found used in Ṛg-Jyotiṣa to denote a year. The Yajur-Jyotiṣa gives an additional word Abda for it (*See* 28th verse). The words 'Varṣa' and 'Abda' occur only in Śatapatha Brāhmaṇa of the Vedic literature.

The Month

The months ended with New Moon in this system.

The First Nakṣatra

The first nakṣatra according to Vedāṅga Jyotiṣa is Dhaniṣṭhā. The list of controlling deities of nakṣatras as given in Ṛk verses 25, 26 and 27 begins, as in the Vedas from Kṛttikās. One comes across a reference of the Dhaniṣṭhādi system in the Mahābhārata. The sixty-year cycle and 12-year Jovian cycle begin from Dhaniṣṭhās.

Arithmetic

People in Vedāṅga Jyotiṣa time knew four fundamental rules and the rule of three. Not only this, but one can say from verses 7, 14, 16, 17, 18 and 22 of Ṛk-reading and 37th verse of Yajur-reading that they had knowledge of these rules about fractions also. Also the use of shortcuts like Apavarta (simplification) etc. shows that they had taken much pains over the mastery of arithmetic.

The Ascendant (Lagna)

The line "Śraviṣṭhābhyāṃ" etc. in verse 19 of Ṛk-reading suggests that they had the idea of Lagna *i.e.* ascendant. The astronomical works define Lagna as the point of the ecliptic in contact with the horizon. The above verse should be regarded as very important if it means to say something like the definition.

Meṣa and other signs

It does not mention any Rāśis (signs) nor was then the system of stating a planet's place with respect to 12 divisions of the ecliptic. The positions of the sun and the moon are given with respect to nakṣatras.

Solar Months

Although no mention of Meṣa and other signs is made, the solar months are stated. The word Sūryamāsa actually occurs, and the relation between the solar and lunar months is given in clear terms at good many places. A season is mentioned to consist of 2 solar months or of 4½ solar-nakṣatras and the lunar months with the tithis on which the seasons commence are also specifically mentioned. Again, it contains a method somewhat similar to the one of calculating 'Adhimāsaśeṣa' with respect to the solar and lunar months and described by Sūrya-Siddhānta and similar other works (*See* verse 23, Ṛk-version). No solar month had any independent (special) names. These were perhaps named as Caitra, Vaiśākha, etc., as we find with regard to solar months in Bengal.

Parvagaṇa (*i.e.* number of lunations)

This work describes a method of calculating the "parvagaṇa' or number of parvas or lunations elapsed from the commencement of Yuga, much on the lines of calculating 'Ahargaṇa' as described by Sūrya Siddhānta and others.

Identical divisions for time and space

Discussion of this topic will be completed after recording a more important thing. It is the identical division system for both time and space, which came into existence from the time Vedāṅga Jyotiṣa was compiled. In astronomical works like Sūrya-Siddhānta we find exact similarity in the divisions and subdivisions of time and space as described below :—

60 Palas	= 1 Ghaṭikā	60 Vikalās	= 1 Kalā
60 Ghaṭikās	= 1 Day	60 Kalās	= 1 Aṃśa
30 Days	= 1 Month	30 Aṃśas	= 1 Rāśi
12 Months or 360 Days	= 1 Year	12 Rāśis or 360 Aṃśas	= 1 Perimeter of a circle

Under Vedāṅga Jyotiṣa system the time division and space divisions are identical. The nakṣatra is supposed to be divided into 610 Kalās; and a day is supposed to be divided into 603 parts, because the moon passes over so many parts (*i.e.* 603 Kalās) of a nakṣatra in 1 day. This subdivision of a day into 603 parts might be found inconvenient for calculation, but this subdivision is convenient when nakṣatras are concerned. The time division is seen to have been suggested by space division. Similarly, the division of 1 yuga into 124 parvas had suggested the division of one nakṣatra into 124 parts or 'Aṃśa'. This is an example of a time division suggesting a space division. Now looking to the fact that the above system was actually in vogue in Vedāṅga Jyotiṣa period and that from Vedic times the relations "1 year=360 days, 1 solar year=12 months, 1 month=30 days and 1 day=60 nāḍikās" have remained in general use, can we not say that these were sufficient enough easily to suggest an Aryan mind that a circular space be divided into 12 parts and each part into 30 subdivisions and that the current space-subdivisions are a result of independent thinking on the part of the Aryans?

(3) ATHARVA JYOTIṢA

The time units

Let us now turn to the study of Atharva Jyotiṣa. This consists of 14 chapters and 162 verses. This has been told to Kāśyapa by Pitāmaha. The author explains its topics briefly.

The time units are given as follows :—

12 Nimeṣa	= 1 Lava	30 Truṭis	= 1 Muhūrta
30 Lavas	= 1 Kalā	30 Muhūrtas	= 1 Ahorātra (whole day)
30 Kalās	= 1 Truṭi		

These are followed by a list of names of 15 Muhūrtas whose measure is compared with the length of a gnomon 12 'aṅgulas' long. The Muhūrtas are :—

Muhūrta	Shadow length (in aṅgulas)	Muhūrta	Shadow length (in aṅgulas)
1. Raudra	96 (max.)	5. Sāvitra	5
2. Sveta	60	6. Vairāja	4
3. Maitra	12	7. Viśvāvasu	3
4. Sārabhaṭa	6	8. Abhijit	

Abhijit has been described as that Muhūrta in which the shadow does not alter in length or direction. The lengths of shadows of Muhūrtas coming after noon increase in the reverse order. It cannot be said that the shadow at noon is of zero length, but it must be shorter than 3 aṅgulas. The place where this Jyotiṣa was compiled can be found out from this condition; but because the lengths of shadows are not the same throughout the year and it is not an important problem worthwhile attempting, the author leaves out of consideration the problem of finding the place.

The Karaṇas and Auspicious times

As we proceed further on we come across instructions about the duties to be performed on particular muhūrtas *e.g.* horrorful acts to be done on Raudra (Terrifying) Muhūrta, and friendly acts to be done on Maitra Muhūrta. The fourth chapter gives a list of Karaṇas (of Tithis) with their names which are like those of our present time. Of the stationary Karaṇas "Kiṃstughna" is substituted by "Kaustubha". It may be a writer's error. Further on, we find a classification of Karaṇas responsible for auspicious and inauspicious acts and the ghatikā has been adopted as a time-unit for them. Further on are given, as at present, names of deities controlling the Karaṇas. They include the Dhanādhipa of Kaustubha and Manibhadra of Vaṇija. The names of remaining deities are those from the Vedas. Next we find a discussion as to which acts, when done on particular tithis, would give auspicious or inauspicious results. This list of tithis includes 5 names like Nandā and Bhadrā—

चतुर्भिः कारयेत्कर्म सिद्धिहेतोर्विचक्षणः ॥
तिथिनक्षत्रकरणमुहूर्तैरीति निश्चयः ॥

This verse gives only four "Aṅgas" (*i.e.* parts) *viz.* Tithi, Nakṣatra, Karaṇa and Muhūrta, and not the Yogas.

तिथिरेकगुणा प्रोक्ता नक्षत्रं च चतुर्गुणं ॥ वारश्चाष्टगुणः प्रोक्तः करणं षोडशान्वितं ॥ ६० ॥
द्वात्रिंशद्गुणो योगस्तारा षष्ठिसमन्विता ॥ चंद्रः शतगुणः प्रोक्तस्तस्माच्चंद्रबलाबलं ॥ ६१ ॥
समीक्ष्य चंद्रस्य बलाबलानि ग्रहाः प्रयच्छंति शुभाशुभानि

These verses discuss the auspicious or inauspicious nature of planets depending, of course, on the "strength" of the moon; and the words "*Na Kṛṣṇapakṣe śaśinaḥ prabhāvaḥ*" suggest the moon's strength varies with the number of its "Kalās".

Vara or names of days and names of planets

The following verse gives names of seven days in a week calling the planets as 'Lords of days'.

आदित्यः सोमो भौमश्च तथा बुधबृहस्पती ॥ भार्गवः शनैश्चरस्चैव एते सप्त दिनाधिपाः ॥६३॥

Other verses give following more names of planets as being applicable to names of days:—Sūrya, Lohitāṅga, Somasuta, Devaguru, Guru, Bhṛgu, Śukra, Sūryasuta.

Jātaka branch of Astrology

After passing over 100 verses, one comes across the quotation

अल्पग्रंथ महार्घं च प्रवक्ष्यामि भृगोर्मतं ॥

which is followed by 62 more verses. This portion contains the seeds of predictional section of astrology Jātaka and is, therefore, an important one. Some of the verses are given below :

The nakṣatras are divided into 9 groups:—

जन्म संपद्विपत्क्षेम्यः प्रत्वरः साधकस्तथा ।। १०३ ।। नैधनो मित्रवर्गश्च परमो मैत्र एव च ।।
दशमं जन्मनक्षत्रात्कर्मनक्षत्रमुच्यते ।। एकोनविंशतिं चैव गर्भाधानकमुच्यते ।। १०४ ।।
द्वितीयमेकादशं विंशमेष संपत्करो गणः ।। तृतीयमेकविंशं तु द्वादशं तु विपत्करम् ।। १०५ ।।
क्षेम्यं चतुर्थं द्वाविंशं तथा यच्च त्रयोदशं ।। प्रत्वरं पंचमं विद्यात्त्रयोविंशं चतुर्दशं ।। १०६ ।।
साधकं तु चतुर्विंशं षष्ठं पंचदशं च यत् ।। नैधनं पंचविंशं तु षोडशं सप्तमं तथा ।। १०७ ।।
मैत्रे सप्तदशं विद्यात्षड्विंशमितिचाष्टमं ।। सप्तविंशं परं मैत्रं नवमष्टादशं च यत् ।। १०८ ।।

Order of groups	*Nakṣatra numbers*		
(1)	1 Nakṣatra at birth	10 Nak. for action	19 Nak. for foundation
(2)	2	11	20 Sampatkara Nak.
(3)	3	12	21 Vipatkara Nak.
(4)	4	13	22 Kṣemya Nak.
(5)	5	14	23 Pratvara Nak.
(6)	6	15	24 Sādhaka Nak.
(7)	7	16	25 Naidhana Nak.
(8)	8	17	26 Maitra Nak.
(9)	9	18	27 Paramamaitra Nak.

Each group consists of 3 nakṣatras separated by 9. These are to be reckoned from the nakṣatra at birth ; this is clear from verse No. 104. The next verses ordain to do or not to do certain acts on these nakṣatras and by the next verse *viz.*,

ग्रहोल्काशनिनिर्घातैः कंपैर्दाहैश्च पीडयत ।। यद्भूयं भवति तत् तत्प्रवक्ष्याम्यशेषतः ।। १२२ ।।

The author describes the fears and horrors which befall when certain nakṣatras are accompanied by planets, electric charges, meteors etc. It is evident that by the word 'graha' the planets Sun, Moon and others are meant. Further on something is stated about conception and the discussion is closed by the verses:—

आत्मज्योतिषमित्युक्तं स्वयमुक्तं स्वयंभुवा ।। तत्वतः पृच्छमानस्य काश्यपस्य महात्मनः ।। १६१ ।।

य इदं पठते विप्रो विधिवच्च समाहितः ।। यथोक्तं लभते सर्वमाम्नायविधिदर्शनात् ।। १६२ ।।

No mention is made that the work is to be called Atharva Jyotiṣa; still that it is so is borne by the evidence of the last verse ending with the remark "*Āmnāyavidhidarśanāt*".

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It is clear from its topics that this Jyotiṣa is not so ancient as the Ṛk or Yajur-Jyotiṣas, still the old consideration of the fact that if the Meṣādi rāśis would have been in vogue in the time of the author of this work, they would rtainly have occurred in the text, leads one to accept that the Atharva otiṣa is pretty old and because it is so called, the author took it for scussion at this place.

One more important point, worth remembering, is that while no mention is made of 12 rāśis, the names of days (Vāra) do occur; this point will be considered later on.

This work describes a system of astrology, very akin to and not quite different from, the one which is based on 12 rāśis and is in use in our country; and no doubt can be entertained about the fact that this system of astrology originated and had been independently developed in our country. It seems probable that although the Hindus are said to have borrowed the 12 rāśis from foreigners, they developed the Rāśi-Jyotiṣa on the already known lines of astrology related to nakṣatras.

2. KALPA SŪTRAS

Āśvalāyana Sūtra

Names of nakṣatra months are found in Āśvalāyana Sūtra. "*Śrāvaṇyāṃ Paurṇamāsyāṃ Śravaṇakarma*" is an example (*See* Gṛhya Sūtra 2-1-1). The names of months like Madhu, Mādhava, etc. are also found (Śrauta Sūtra 4-12). At one place, a reference about seasons in the same quotation shows that Spring was regarded as the first season. Although the word tithi does not occur explicitly, the quotations (i) "*Mārgaśīrṣyāṃ Pratyavarohaṇaṃ Caturdaśyāṃ*" (Gṛ. S. 2-3-1) (ii) "*Hemantaśiśirayoścaturṇāmaparapakṣā-ṇāmaṣṭamīṣvaṣṭakāh*" (Gṛ. S. 2-4-1) (iii) "*Adhyāyopākaraṇaṃ Śrāvaṇ-asya Pañcamyāṃ*" (3-5) etc. show that the words Caturdaśī, Aṣṭamī, Pañcamī stand for tithis. References about Ayana and Viṣuva occur at good many places. The references about nakṣatras show that some are used in dual form as, '*Uttarayoḥ Proṣṭhapadayoḥ*' (Gṛ. S. 2-1) and in masculine gender plural number also as in '*Uttaraiḥ proṣṭhapadaiḥ*' (Gṛ. S. 2-10-3). In Taittirīya Brāhmaṇas, both these star-names are used in masculine and plural number. The names of Pole star(Dhruva), the Great Bear (Saptarṣi) and Arundhatī occur in Gṛ S. 1-7-22 as "*Dhruvamarundhatīm Saptarṣīniti dṛṣṭvā vācam visṛjeta*". Definite instruction for doing certain rites on certain auspicious nakṣatras seems to be given in it ; *e.g.* Fields should be ploughed on the Uttara Proṣṭhapada, Phalgunī and Rohiṇī nakṣatras, sacrifices should begin on such and such nakṣatras (Gṛ. S. 2-10-3); the thread ceremony should be performed on auspicious nakṣatras; the Sīmantonnayanam to be performed on 'masculine' nakṣatras conjoined with moon (Gṛ. S. 1-4-1, 1-14.) etc. Which nakṣatras were regarded as auspicious and masculine, is not known. The current works on astrology give a list of masculine and feminine nakṣatras ; and the kinds of nakṣatras are similar to those shown on page 48-50. People might be following the same kind of grouping in Sūtra period.

Pāraskara Sūtra

Pāraskara Sūtra seems to belong to a period later than the Āśvalāyana Sūtra. It contains almost all topics discussed by Āśvalāyana Sūtra ; but it ordains the "Āgrahāyaṇī-karma" to be performed on the full moon day of

Mārgaśīrṣa—no mention of this act is made in the Āśvalāyana Sūtra. It also gives "*triṣu triṣu uttarādiṣu svātau mṛgaśirasi rohiṇyām*" as the list of nakṣatras auspicious for marriage. Haradatta defines these as "Uttarā, Hasta, Citrā, Uttarāṣāḍhā, Śravaṇa, Dhaniṣṭhā, Uttarābhādrapadā, Revatī and Aśvinī". The current works on Muhūrta do not give Citrā, Śravaṇa, Dhaniṣṭhā and Aśvinī as marriage-nakṣatras. Similarly, Jyeṣṭhā has been recommended for ploughing the field (2-16). The list of marriage-nakṣatras given by one Sūtra does not agree with that given by another. This Sūtra (Pāraskara) describes the results, if a child birth takes place on Mūla Nakṣatra *e.g.* "if born on the first part, the father dies; if on the second, the mother; if it be born on the 3rd, the loss of money and corn results and the whole family suffers if born on the fourth part (1.21)". It is worth noting that a nakṣatra is divided into 4 parts. If the ecliptic were to be divided into 12 parts, a nakṣatra necessitates a division into 4 parts. Different works express different opinion about birth of children on Mūla nakṣatra. The Taittirīya Śruti, however, appears to carry better opinion regarding birth on Mūla nakṣatra (Tai. Br. 3-1-2). Pāraskara Sūtra describes the inauspicious nature of "Āśreṣā Star" (1.21). The topics of intercalary months, tithi vṛddhi and nakṣatra vṛddhi do not occur in either Āṣvalāyana or Pāraskara Sūtra. The names of seven days (7 vāras), the rāśis, yogas and karaṇas also are not found in either of them.

Other Sūtras

The Hiraṇyakeśī and Āpastamba Sūtras contain almost all the subjects discussed by the Pāraskara and Āśvalāyana Sūtras. The rāśis and names of days do not occur in these sūtras also. All these sūtras define a spring season as composed of either Caitra and Vaiśākha or Madhu and Mādhava months. The Baudhāyana Sūtra defines the spring as "*Mīna Meṣayoḥ Meṣa Vṛṣabhayoḥ Vasantaḥ*" The names of 12 rāśis occur there. The quotation (given on page 21) from Maitreya Sūtra refers to the Sun's entry into signs and the word 'Rāśi' is found used by them. The author feels that much more information regarding astrological subjects could be gathered from the Sūtra works ; but he could not get a chance of reading other Sūtras.

3. NIRUKTA[1]

Some astronomical references from Nirukta have already been given in the first part. The terms "Muhūrta" and "Kṣaṇa" have occurred in the 25th section of the 2nd Chapter. One comes across a reference to Saptarṣi in the quotation "*Saptarṣiṇāni Jyotīṃṣi*" (*See* 10-26). One comes across some thoughts* of a surprising nature about the terms day, night, light-half and dark-half of a month and winter and summer solstices which occur in them.

अथ ये हिंसामाश्रित्य विद्यामुत्सृज्य महत्तपस्तेपि रेचिरेण बेदोक्तानि वा कर्माणि कुर्वंति ते धूममभिसंभवंति धूमाद्रात्रिं रात्रेरपक्षीयमाणपक्षमपक्षीयमाणपक्षाद्दक्षिणायनं दक्षिणायनात्पितृलोकं प्रतिपद्यंते ॥ ८ ॥ अथ ये हिंसामुत्सृज्य विद्यामाश्रित्य महत्तपस्तेपिरे ज्ञानोक्तानि वा कर्माणि कुर्वंति

*Verses 8 and 9 from Chapter 14 and quoted below, describes how persons go to higher worlds if they (i) forsake study, commit cruel acts, but ultimately take to doing a penance or (ii) forsake cruel deeds, take up to study and also a penance in the end. The statement "*Ākāśaguṇaḥ sabdaḥ*.............." from the same chapter is important and worth reading. We come across similar thoughts in Yājñavalkya Smṛti and Bhagabadgītā also.

तेऽर्चिरभिसंभवंत्यर्चिषोहरह्न आपूर्यमाणपक्षमापूर्यमाणपक्षात्‌दुगयनमुदगयनाद्देवलोकं देवलोकादा-
दित्यमादित्याद्वैद्युतं वैद्युतान्मानसं मानसः पुरुषो भूत्वा ब्रह्मलोकमभिसंभवंति ते न पुनरावर्तंते
शिष्टा दंदशूका यत इदं न जानंति तस्मादिदं वेदितव्यमथाप्याह ॥ ८ ॥

अध्याय १४.

आकाशगुणः शब्द आकाशाद्वायुर्द्विगुणः स्पर्शेन वायोर्ज्योतिस्त्रिगुणं रूपेण ज्योतिष आपश्चतुर्गुण ।
रसेनाद्भ्यः पृथिवी पंचगुणा गंधेन पृथिव्या भूतग्रामस्थावरजंगमास्तदेतदहर्युगसहस्रं जागर्ति
तस्यांते सुषुप्स्यन्नंगानि प्रत्याहरति भूतग्रामाः पृथिवीमपि यंति पृथिव्यप आपो ज्योतिषं
ज्योतिर्वायुं वायुराकाशमाकाशो मनो मनो विद्यां विद्या महांतमात्मानं महानात्मा प्रतिभां
प्रतिभा प्रकृतिं सा स्वपिति युगसहस्रं रात्रिस्तावेतावहोरात्रावजस्रं परिवर्तेते स कालस्तदेतदहर्भव
युगसहस्रपर्यंतमहर्यद् ब्रह्मणो विदू रात्रिं युगसहस्रांतां तेहोरात्रविदो जना इति ॥ ४ ॥

अध्याय १४.

Yuga and Other Units of Time

The description about these time units is mostly similar to that found in Manusmṛti and astronomical works. The Nirukta defines Brahmā's one day as the period of 1000 yugas, no clue being given as to the measure of a yuga in years; during this time the creation, maintenance and destruction of the Universe take place. Brahmā's night also is of the same length (i.e. 1000 yugas) during which time he sleeps ; the period of 'a day plus a night' is called Brahmā's "ahorātra". These repeat continuously infinite number of times. The period of Brahmā's 'ahorātra' is identical with the one known as 'Kalpa' to the Sūrya Siddhānta and other astronomical works. The word 'Kalpa' does not occur in it. It is needless to say that Nirukta is the most ancient of all works which describe the long period of Yuga and other units. Although nothing is said about the measure of a yuga in terms of solar years, it is certain that it was definitely not so small a measure as five years. However the statements on the whole suggest some larger length for this term.

4. PĀṆINĪ'S GRAMMAR

One comes across words like 'Varṣa' (5-1-88, 7-3-16) and 'Hāyana' (4-1-27 ; 5-1-130), occasionally found in the Vedas. One can read about lunar months denoted by Caitra etc. (4-1-21) and the term 'Muhūrta' (indicating a part of a day) (3-3-9). Similarly the term 'Nāḍi' denoting a number one or more than one (and not denoting a sinew in the body) occurs in it (5-4-159). This shows that the term 'Nāḍi' was used to indicate some measure of time. The term 'tithi' is not found in Pāṇinī ; but one should not say from this that the term was unknown to people in Pāṇinī's time. This grammatical work does not deal with astronomical subjects or religious topics such as the commands to do or not to do certain acts on certain nakṣatras. Hence, we can not say that the astronomical terms which do not occur in this work were unknown in his time. Also, of the names of yuga's (Kṛta etc.), the term Kali does occur in Pāṇinī, but not in the sense of a yuga ; this is not sufficient to prove that the Kṛta and other units of yuga were unknown in Pāṇinī's time.

The names of nakṣatra's are found in this work. The names 'Puṣya' and 'Sidhya' are found used in place of 'Tiṣya' (3-1-116). Similarly, 'Śravaṇa' used in Atharva-Veda only is found used in place of 'Śroṇā' (See 4-2-23). One comes across the statements, "The singular form for Punarvasu (1-2-61) and dual for Viśākhā (1-2-62) are to be accepted according to 'Chandas' i.e. Vedas", but in no Śruti-works read by him the author finds these nakṣatra names used in the singular. He can not say, if they are found so used in Vedic work not known to him. The term 'Proṣṭhapadā' is used in dual and plural (1-2-60). Similarly the quotation "Vibhāṣāgrahaḥ"(3-1-143) leads one to suspect that a planet was taken to be a star.

CHAPTER II—SMṚTI, MAHĀBHĀRATA, ETC.

MANU SMṚTI

The Yuga-System

The Yuga system is described in details in the first chapter of Manusmṛti. The same system is generally given in Purāṇas and astronomical works. The text is, therefore, given below for reference.

ब्राह्मस्य तु क्षपाहस्य यत् प्रमाणं समासतः ॥ एकैकशो युगानां तु क्रमशस्तन्निबोधत ॥ ६८ ॥

चत्वार्याहुः सहस्राणि वर्षाणां तत्कृतं युगं ॥ तस्य तावच्छती संध्या संध्यांशश्च तथाविधः ॥ ६९ ॥

इतरेषु ससंध्यषु ससंध्यांशेषु च त्रिषु ॥ एकापायेन वर्तन्ते सहस्राणि शतानि च ॥ ७० ॥

यदेतत्परिसंख्यातमादावेव चतुर्युगं ॥ एतद् द्वादशसाहस्रं देवानां युगमुच्यते ॥ ७१ ॥

दैविकानां युगानां तु सहस्रपरिसंख्यया ॥ ब्राह्ममेकमहर्ज्ञेयं तावतीं रात्रिमेव च ॥ ७२ ॥

तद्वै युगसहस्रांतं ब्राह्मं पुण्यमहर्विदुः ॥ रात्रिं च तावतीमेव तेऽहोरात्रविदो जनाः ॥ ७३ ॥

तस्य सोऽहर्निशस्यान्ते प्रसुप्तः प्रतिबुध्यते ॥ प्रतिबुद्धश्च सृजति मनः सदसदात्मकं ॥ ७४ ॥

मनः सृष्टिं विकुरुते चोद्यमानं सिसृक्षया ॥ आकाशं जायते तस्मात्तस्य शब्दं गुणं विदुः ॥ ७५ ॥

आकाशात्तु विकुर्बाणात्सर्बगंधवहः शुचिः ॥ बलवाञ्जायते वायुः स वै स्पर्शगुणो मतः ॥ ७६ ॥

वायोरपि विकुर्बाणाद्विरोचिष्णु तमोनुदम् ॥ ज्योतिरुत्पद्यते भास्वत्तद्रूपगुणमुच्यते ॥ ७७ ॥

ज्योतिषश्च विकुर्बाणादापो रसगुणाः स्मृताः ॥ अद्भ्यो गन्धगुणा भूमिरित्येषा सृष्टिरादितः ॥ ७८ ॥

यत्प्राक् द्वादशसाहस्रमुदितं दैविकं युगं ॥ तदेकसप्ततिगुणं मन्वन्तरमिहोच्यते ॥ ७९ ॥

मन्वंतराण्यसंख्यानि सर्गः संहार एवच ॥ क्रीडन्निवैतत्कुरुते परमेष्ठी पुनः पुनः ॥ ८० ॥

चतुष्पात्सकलो धर्मः सत्यं चैव कृते युग ॥ नाधर्मेणागमः कश्चिन्मनुष्यान्प्रतिवर्तते ॥ ८१ ॥

इतरेष्वागमाद्धर्मः पादशस्त्ववरोपितः ॥ चौरिकानृतमायाभिर्धर्मश्चापैति पादश ॥ ८२ ॥

अरोगाः सर्वसिद्धार्थाश्चतुर्वर्षशतायुषः ॥ कृते त्रेतादिषु ह्येषामायुर्ह्रसति पादशः ॥ ८३ ॥

वेदोक्तमायुर्मर्त्यानामाशिषश्चैव कर्मणाम् ॥ फलंत्यनुयुगं लोके प्रभावश्च शरीरिणाम् ॥ ८४ ॥

अन्ये कृतयुगे धर्मास्त्रेतायां द्वापरे परे ॥ अन्ये कलियुगे नृणां युगह्रासानुरूपतः ॥ ८५ ॥

तपः परं कृतयुगे त्रेतायां ज्ञानमुच्यते ॥ द्वापरे यज्ञमेवाहुर्दानमेकं कलौ युगे ॥ ८६ ॥

The lengthy units of time, Kṛta and others, as described in the above verses are given in a tabular form below :—

Yuga name		Years	Yuga name		Years
1. KṚTA	Transition period	400	3. DVĀPARA	Transition period	200
	Central period	4000		Central period	2000
	Transition period	400		Transition period	200
2. TRETĀ	Transition period	300	4. KALI	Transition period	100
	Central period	3000		Central period	1000
	Transition period	300		Transition period	100

Total of four Yugas=12,000 years=Divine Yuga. 1000 Divine Yugas= 12,000,000 years=Brahmā's day. In this scheme, a divine Yuga is considered to be equivalent to 12,000 years ; but it is not clear if these years are to be regarded as divine. Now, taking one divine year as equivalent to 360 'human' years, the divine yuga will be equivalent to 360 times 12000, that is, equal to 4,320,000 ordinary human years. In the opinion of Whitney*, the years to be divine years is not Manu's idea, it has been the result of later thought. But this is not correct.

That the divine year is a period far greater than an ordinary year was a well known idea even before Manu. A quotation from Taittirīya Saṃhitā given on page 65, clearly states that the ordinary year (human) which consists of 360 days is equivalent to a 'divine day'. Hence, following the same analogy, one divine year is equal to 360 human (ordinary) years ; and although Manu does not explicitly state 12000 years as divine years, the next unit (Divine yuga) is sufficiently suggestive to mean that the term "years" stands for divine years. The measure, "1 divine yuga=360× 12000=4320000 years" is doubtless a unit of time well known in Manu's time ; and 1000 such years are said to be Brahmā's day. This measure is equal to that of Kalpa described by astronomical works, although the word 'Kalpa' is not mentioned by Manu. It is the author's conviction that the units of time, *viz.*, "Kṛta and other yugas, Mahāyugas, and Kalpa", which are described by astronomical works, were already established as standard unit of time, not only in Manu's time, but in the time of Yāska, the author of Nirukta, because the ideas given in verses 72 and 73 of Manu Smṛti are identical with those given by Nirukta in the last paragraph. He has clearly stated that a Brahmā's day consists of 1000 years ; although he neither says that these years were divine nor does he mention one yuga to consist of 12000 years, the names of yugas *viz.* Kṛta and others are found in the Vedas, so they belong to a period older than Nirukta. Also, the term "yuga" according to Nirukta, indicates a unit of time which was something very long ; hence it is believed that the standard units of time given by the Sūrya-Siddhānta and others, had been well established in the time of Nirukta ; and that it was

*See translation of Sūrya Siddhānta, page 10, by Burgess.

well set into standard form in Manu's time is doubtlessly true. The Mahābhārata mentions a yuga system similar to that given by Manu, and it will be described later on. European scholars believe that the Mahābhārata was compiled after Manusmṛti ; even if it be supposed that is was compiled earlier, it would lend a support to the belief that the standard yuga system was established long before Manu's time.

The signs of advent of different yugas are given by Manu in terms of prevailing religious conditions ; similar conditions are described by the Purāṇas also. The measure of the period known as 'Manu' is the same as given by the Sūrya-Siddhānta.

Manu Smṛti does not mention any names of planets or those of Rāśis; it does not give anything else of astronomical importance.

YĀJÑAVALKYA SMṚTI

Names of Week Days

This Smṛti describes a sacrifice in honour of planets, whose names are given in the following lines.

सूर्यः सोमो महीपुत्रः सोमपुत्रो बृहस्पतिः ॥२९५॥
शुक्रः शनैश्चरो राहुः केतुश्चैते ग्रहाः स्मृताः ॥

आचाराध्याय.

The names of seven days and their Lords are not explicitly mentioned, but the order of names of planets is given exactly in the order of week days ; this shows that the names of seven days of a week were known in the time of Yājñavalkya Smṛti. The Atharva Jyotiṣa mentions seven planets in relation to seven days, but it does not mention Rāhu and Ketu ; but Yājñavalkya Smṛti mentions nine planets and the incantations (mantras) to be chanted in their honour* which are found in vogue in the present time. Scholars believe that Yājñavalkya Smṛti belongs to a very later period, later than Manu Smṛti and the references of planets and names of week-days lends a support to this view.

The Yuga-System

This Smṛti does not give the names of "Kṛtādi" yugas and their measures; but a solitary reference *viz.*,

मन्वंतरैर्युगप्राप्त्या

३.१७३.

shows that the system described by Manu Smṛti was then in vogue.

Twelve Parts of the Ecliptic

The following lines give proper times for performing the 'Śrāddha' ceremonies :—

आमावास्याष्टका वृद्धिः कृष्णपक्षोऽयनद्वयं ॥
द्रव्यं ब्राह्मणसंपत्तिर्विषुवत्सूर्यसंक्रमः ॥२१७॥
व्यतीपातो गजच्छाया ग्रहणं चंद्रसूर्ययोः ॥

आचाराध्याय.

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* See verses 299-301, Ācārādhyāya.

This work gives the word 'Sūrya Saṃkrama'. It is not, therefore, necessary to infer that the names of Rāśis (Meṣa etc.) were known then. The terms are nowhere found in Yājñavalkya Smṛti and only at one place we get a reference of nakṣatra names (*See* 'Kṛttikādi Bharaṇyantaṃ' 1.267). It has already been pointed out that although the Rāśi-terms were not in vogue in the Vedāṅga Jyotiṣa period, the ecliptic was supposed to be divided into 12 parts. It is also said that according to some European scholars the names of seven days and 12 signs have been borrowed by the Hindus, and on the basis of this assumption one would argue that the Sanskrit work which gives names of week days must give names of Rāśis also. But it has been shown on page 100 that Atharva Jyotiṣa does not give Rāśis although it gives names of week days ; and it will be shown later on in the study of Mahābhārata that the Indians, long before the introduction of the terms 'vāra' and 'rāśi', had adopted the division of the ecliptic into 12 parts for the calculation of Sun's position and motion. The term 'Saṃkramaṇa' could be used to denote the crossing of the sun into a part of the ecliptic, no matter if the ecliptic be regarded as divided into 12 parts or in 9 parts according to Atharva Jyotiṣa. The above lines show that the word 'Saṃkrama' has come in along with the 'Ayanas' (solstices) and 'Viṣuva' (equinoxes). It is thus proved that the ecliptic was divided into 12 parts in the times of Yājñavalkya Smṛti.

Anyway, the study of Atharva Jyotiṣa and Yājñavalkya Smṛti proves that the names of week-days and 12 rāśis did not come into use simultaneously; the 'vāras' came into vogue before the rāśi-names.

Yoga

The word 'Vṛddhi' occurs in the lines giving auspicious times for Śrāddha quoted on prepage ; it is doubtful if this is one of 27 yogas given by astronomical works. The author thinks that it stands for 'increase' of "wealth, brāhmaṇas, money" etc., occurring in the same lines.

Other Matters of Interest

The word 'Vyatīpāta' also comes in the same sloka. It definitely stands for the astronomical 'yoga'. At another place (Prāyaścittādhyāya, verse 171) we come across a quotation "*grahasaṃyogajaiḥ phalaiḥ*". This shows that people were attracted by the phenomena of planetary conjunctions and that they had begun to discuss about their probable auspicious (benefic) and in-auspicious (malefic) effects. If the time of Yājñavalkya Smṛti had been decided beyond doubt, it would have been possible to draw some more important inferences ; still, the author records his opinion here that the Indians had the knowledge of Rāhu, Ketu, the order of week days, Vyatīpāta and the conjunctions of planets.

पितृयानाऽजवीथ्याश्च यदगस्त्यस्य चांतरं ।। तेनाग्निहोत्रिणो यांति स्वर्गकामा दिवं प्रति ।।१८४।।
तत्राष्टाशीतिसाहस्रा मुनयो गृहमेधिनः ।। सप्तर्षिनागवीथ्यंतर्दैवलोकं समाश्रिताः ।।१८७।।

प्रायश्चित्ताध्याय.

We find references of Agastya and Saptarṣi in these lines. Similarly, in the Garga Saṃhitā and other works, they are said forming groups or clusters (Vīthi) of nakṣatras, *e.g.* Aja and Nāga are the names of two vīthis occurring

in them. There are differences of opinion regarding the formation of nakṣatras into groups and their number ; some take 9 as the number, others regard it as 3. Bhaṭotpala has given in details the views of Garga, Parāśara and others in the chapter on 'Śukracāra' in Bṛhat Saṃhitā. People in Yājñavalkya's time, it seems, used to observe the movements of planets with respect to stars, since the vīthis referred to in the above lines are clusters of stars such that the planets were actually observed as moving on one side or the other of them.

People thought that the abode of gods lay in the northern hemisphere of the heavens and the abode of pitṛs (fore-fathers) lay in the southern hemisphere. This view is similar to the ideas given by Śatapatha Brāhmaṇa (page 23).

We find in Yājñavalkya Smṛti (Chapter 3, verses 192 to 197) some discussion about 'ayanas' similar to that found in the quotations from Nirukta. We come across commands that certain religious rites should be performed when the Moon occupies certain benefic nakṣatras (*See* 1-180 etc.) ; they believed that the ominous influence of malefic planets is overcome by worshipping them (*See* 1-306); mourning was to be observed in the case of Rāhu. The tithis and muhūrtas also occur in the Smṛti ; it also describes the reverential status of astronomers (*See* 1-312, 332).

MAHĀBHĀRATA

The astronomical references found in the Mahābhārata are so many in number that it is not possible to enumerate them for want of space. We will consider only those of them which are found very useful from point of view of the present subject matter.

Its Time

Before doing so, it is necessary to consider when the Mahābhārata was compiled ; because the importance of the astronomical references will be the more firmly established. It is very difficult to establish without doubt its time ; however, it can be found by conjecture. Now looking to the text, because the sage Vyāsa is said to have compiled it and Vaiśampāyana recited it to King Janmejaya, the work may appear to have been written at the time of Pāṇdavas or soon after. It seems that the Mahābhārata was in existence in the time of Pāṇinī. There is a direct reference of the Mahābhārata in the Āśvalāyana Sūtra and that it has already been proved from philological evidences that Āśvalāyana lived before Pāṇini. This definitely shows that the Mahābhārata* is a very ancient work. It may however be possible that a major part of what is known as the Mahābhārata to-day is of a later origin ; even from astronomical evidence it can be said that several portions may have belonged to different periods. But an information of an important research about the interpolated portion must be given here.

The belief that the Mahābhārata contains a lac (100000) of verses should not be said to belong to the present time only. Under orders of the Government of India, ancient inscriptions on copper plates and stones are being published in a series of books entitled "Inscriptionum Indicarum". The third part of the series contains inscriptions of Gupta Kings, which includes an inscription (belonging to Samvat 197) of King Sarvanātha of Uccakalpa (*See* page

*It is Prof. Kunte's view that Pāṇinī knew the Mahābhārata. See page 448, "Vicissitud yan civilization".

134 of the said book) which clearly states that the Mahābhārata consists of 1 lac verses. It is established beyond doubt that the samvat quoted in it is Cedi (Kalacurī) (*See* Indian Antiquary, XIX 227 f ; XVII 215). Now 197 Cedi= (197+170)=367 Śaka=445 A. D. This shows that nothing new was interpolated in the Mahābhārata after 4th century (Śaka); and it is also true that at least some portion of it was written in Pāṇḍavas' time, whatever that time be. The 'Upākhyānas', subsidiary stories and lengthy descriptions of fights can possibly have been interpolated afterwards. But it is not very probable that the original story about Pāṇḍavas and important references about the position of certain planets near about particular nakṣatras at the time of the Mahābhārata battle have been interpolated by some one of his own accord later on. It can not be said about astronomical references found in the Mahābhārata that they have continued in their original form from Pāṇḍavas' time. The astronomical condition might have been handed down traditionally and these have been versified by some one later on. In short, what the author means to say is that the most important of the astronomical references must have been actual facts, traditionally handed down right from Pāṇḍavas' time and the remaining references, if not very old, at least belong to a period as ancient as Āśvalāyana and Pāṇinī.

The author has read the whole of the Mahābhārata from point of view of astronomy, and an important thing which he noticed is that we do not get in it any reference of seven week-days and 12 rāśis. It can, therefore, be said beyond doubt* that the astronomical references in it point to a period prior to the time (whatever that time be) when the week days and rāśis got introduced in our country. According to European scholars, the Hindus have borrowed astronomical knowledge from the Greeks; if they have borrowed it at all, they have not done it from Ptolemy (150 A.D.), but long before him. This fact can be proved easily and the European scholars also admit it. None of them has proved beyond doubt, when the knowledge was gathered ; but they mean to hint that it was borrowed from Hipparchus, the famous Greek astronomer (150 B. C.) and hence, even the Europeans agree that the astronomical references found in the Mahābhārata could not have entered it earlier than 150 B. C.

To possess the knowledge of planetary motions and their causes and of finding their true positions is an important thing and so is inventing a system of names for week-days and those for Méṣa and other Rāśis ; but there is a vast difference between the importance of the two.

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*The author is giving below an interesting information about the Mahābhārata Nirṇayāmṛta, a famous work on Dharmaśāstra, quoting the following lines about Cāturmāsya and as taken from the Mahābhārata :—

वार्षिकांश्चतुरो मासान् व्रतं किंचित्समाचरेत् ।। असंभवे तुलार्के तु कन्यायां तु विशेषतः ।।

But he did not find this verse in the Mahābhārata. Similarly, certain passages about 'ghaṭikāpātra' and attributed to have quoted by the Mahābhārata, are not found in it. The same work, Nirṇayāmṛta, in the chapter on 'Mahālaya' in the second part of Nirṇaya Sindhu quotes the following verse as taken from the Mahābhārata, but he does not find it anywhere in the work :—

यावच्च कन्यातुलयोः क्रमादास्ते दिवाकरः ।। शून्यं प्रेतपुरं तावद् वृश्चिकं यावदागतः ।।

He has written these lines after actually going through the book printed by Ganapat Krishnaji's press. A certain Vaman Sastri Islampurkar has published a news that he has found some original chapters of the Mahābhārata which have not been printed and published.

The first one is a very important thing ; it was not known to anyone in Europe before Hipparchus, the greek astronomer, and even the European scholars admit it; and if the Indians had required some help from the Greeks in this matter, it must have been very little. The second thing is not so important.

Let us now turn to the study of astronomical references found in the Mahābhārata.

The Yuga-System

The Mahābhārata describes Yuga and other units of time on the same lines as given by Manu Smṛti. (*See* Bhārata Vanaparva. Chap. 149, 188, Bhagavadgitā, 8.17; Śāntiparva, Chap. 232, 233 etc.). The names of Kṛta and other yugas have occurred at several places in reference to incidents attributed to be happening in those yugas. Similarly, the term 'Kalpa' denoting a unit of time has occurred at several places (*See* Śāntiparva, Chap. 183 etc.).

The System of Vedāṅga Jyotiṣa

We come across references about 5-year cycle or the system of 5-year yuga, at some places. The five Pāṇḍavas were born, one in each consecutive year. A reference to this is found in the following verse :—

अनुसंवत्सरं जाता अपि ते कुरुसत्तमाः ।। पांडुपुत्रा व्यराजंत पंच संवत्सरा इव ।।२२।।

आदिपर्व, अ. १२४.

Bhīṣma, while calculating the time elapsed after the Pāṇḍavas went into exile, says to Duryodhana on the occasion of Uttara Gograhaṇa as follows—

तेषां कालातिरेकेण ज्योतिषां च व्यतिक्रमात् ।।
पंचमे पंचमे वर्षे द्वौ मासावुपजायतः ।।३।।
एषामभ्यधिका मासाः पंच च द्वादश क्षपाः ।।
त्रयोदशानां बर्षाणामिति मे वर्तते मतिः ।।४।।

विराटपर्व, अ. ५२.

Here we get the reference to the Vedāṅga Jyotiṣa system of inserting two intercalary months in five years.

Under the Vedāṅga Jyotiṣa system, the nakṣatra-cycle begins from Dhaniṣṭhās, which means that Dhaniṣṭhā must be considered to be at the origin while stating a planetary position. The Kṛttikās were once regarded as the first nakṣatra before Dhaniṣṭhās. An interesting story about the Dhaniṣṭhādi system is related in the Mahābhārata as follows :—

अभिजित् स्पर्धमाना तु रोहिण्या कन्यसी स्वसा ।।
इच्छंती ज्येष्ठतां देबी तपस्तप्तुं वनं गता ।।८।।
तत्र मूढोस्मि भद्रं ते नक्षत्रं गगनात् च्युतं ।।
कालं त्विमं परं स्कंद ब्रह्मणा सह चिंतय ।।९।।
धनिष्ठादिस्तदा कालो ब्रह्मणा परिकल्पितः ।।
रोहिणी ह्यभवत्पूर्वमेवं संख्या समाभवत् ।।१०।।

एवमुक्ते तु शुक्रेण कृत्तिकास्त्रिदिवं गताः ॥
नक्षत्रं सप्तशीर्षाभं भाति तद्वह्निदैवतं ॥११॥

वनपर्व अ. २३०.

These lines occur in 'Skandākhyāna'. The general sense of the story is not clear to the author. Various current mythical stories about the stars Abhijit, Dhaniṣṭhā, Rohiṇī, Kṛttikā are jumbled up in this chapter, and hence their mutual relationship is not clear. The Dhaniṣṭhādi system is said to have been intrduced by god Brahmā ; the theory underlying this is well known. The next sentence is "before it was Rohiṇī". It is not clear if this refers to the period when Rohiṇī was possibly considered as the first nakṣatra. The important portion of the story is the reference of "star Abhijit's falling down from heavens". The celestial latitude of Abhijit (Alpha-Vega) is 61° North. Hence, owing to the precessional motion of the equinox, it is bound to occupy the position of the pole of the celestial equator ; and it is shown in a well known book* on astronomy that it will be a polar star 12000 years hence. When Abhijit would come to the position of the pole, it would be seen very low near the horizon and is liable to be observed even in the horizon (i.e. in the lowest position). The author suspects that the myth has originated because of such a position of Abhijit actually observed in the past, and this thing can possibly have happened 13000 years ago. The statement "Kṛttikās have gone up in the sky" does not carry any satisfactory sense.

Winter Solstice And Śravaṇa Star

In the Vedāṅga Jyotiṣa period the Winter Solstice used to take place at the beginning of Dhaniṣṭhā ; at present its place is nearabout the commencement of P. Aṣāḍhā and some years ago it used to occur near U. Aṣāḍhā. It must have, therefore, been taking place near Śravaṇa in some age. We come across an important reference about this in the Mahābhārata. While reading an account of how sage Viśvāmitra attempted to create a 'parallel-world' we come across verse No. 34, Chap. 71 from Ādi parva, which runs thus :—

चकारान्यं च लोकं वै क्रुद्धो नक्षत्रसंपदा ॥ प्रतिश्रवणपूर्वाणि नक्षत्राणि चकार यः ॥३४॥

आदिपर्व अ. ७१.

Similarly, the following lines are also worth reading :—

अहः पूर्वं ततो रात्रिर्मासाः शुक्लादयः स्मृताः ॥ श्रवणादीनि ऋक्षाणि ऋतवः शिशिरादयः ॥२॥

अश्वमेधपर्व अ. ४४.

Although it is not stated in clear words that winter solstice used to take place in the beginning of Śravaṇa nakṣatra, there is no other reason for calling the nakṣatras as Śravaṇādīni commencing from Śravaṇa. Like the Vedāṅga Jyotiṣa system, herein also the nakṣatras are 'Śuklādi', that is commencing with light half or ending in New Moons. From this it can, therefore, be inferred that the Vedāṅga Jyotiṣa system continued for few centuries more but in a slight different form. It has already been shown before that the time when winter solstice used to occur near the beginning of Dhaniṣṭhā was about 1400 B. C.; it began to take place in the beginning of Śravaṇa at about 450 B. C.

*Newcomb's Popular Astronomy has given in a map a list of stars which will become polar stars in different ages.

Other Matters

References about seasons, ayanas, Madhu and other months, and tithis are found at several places. The seasons commenced with 'Śiśira', so say the lines. The words "Seasons commencing with spring" also occur at many places. If the year began with W. S., the commencing season must either be Śiśira or Hemanta. The following lines support the view that "Caitra and Vaiśākha constitute the Spring season" was the popularly known relation in those times.

कौमुदे मासि रेवत्यां शरदंते हिमागमे ।। स्फीतसस्यसुखे काले ।।७।।

उद्योगपर्व, अ. ८३.

तेषां पुण्यतमा रात्रिः पर्वसंधौ स्म शारदी ।। तत्रैव वसतामासीत्कार्तिकी जनमे जय ।।१६ ।।

वनपर्व, अ. १८२.

We meet with two lists of names of months in Chap. 106 and 109 of Anuśāsana Parva, in both of which the first month is stated to be Mārgaśirṣa. Even when the verse concerning Śravaṇa nakṣatra states new moon ending month-system, we come across a statement showing that full moon ending month-system was also in vogue. *e.g. see* verse No. 96.

कृष्णशुक्लावुभौ पक्षौ गयायां यो वसेन्नरः ।।९६।।

वनपर्व, अ. ८४.

The following verses contain references about parts and sub-parts of a day. The line from verse No. 21, Chapter 7 from Śānti parva *viz.*,

काष्ठा कला मुहूर्ताश्च दिवा रात्रिस्तथा लवाः ।।२१।।

शांतिपर्व, आपद्ध, अ. ७.

quotes the time-units *viz.* Kalā, Kāṣṭhā, Muhūrta and Lava. Similarly the line

संवत्सरान् ऋतून् मासान् पक्षानथ लवान् क्षणान् ।।१४।।

शांति. आप. अ. ३६.

from verse 14, Chap. 36 of Sāntiparva gives 'Kṣaṇa' as another unit ; but their mutual relationship is nowhere to be found. The term 'muhūrta' occurs at hundreds of places *e.g.*

स भवान पुष्ययोगेन मुहूर्तेन जयेन च ।।१७।। कौरवेयान् प्रयात्वाशु.... ।।

उद्योगपर्व, अ. ६.

quotes the Jaya muhūrta. The Atharva Jyotiṣa gives Vijaya as the name of the 11th muhūrta. The following verse contains the names of Abhijit, the 8th muhūrta, and the term Tithi (but in masculine form).

ऐंद्रे चंद्रसमायुक्ते मुहूर्तेभिजितेष्टमे ।। दिवा मध्यगते सूर्ये तिथौ पूर्णेतिपूजिते ।।६।।
समृद्धयशसं कुंती सुषाव प्रवरं सुतं ।।

आदिपर्व, अ. १२३.

The 8th muhūrta, Abhijit, is famous in the Atharva Jyotiṣa and other astronomical works. The units, ghaṭi and pala are not to be found anywhere in the Mahābhārata ; but the author is not certain about this, since he did not read the work with particular attention to these units.

Week-days

No reference is to be found about 7 days in a week in the Mahābhārata but the author came across a solitary instance in which the word 'Vāra' occurs in the verse No. 7, Chap. 160, Ādiparva. The Pāṇḍavas used to live with a certain Brahmin in the Eka Cakra Nagari, before Draupadī's 'Svayaṃvara' was held. In that city there lived a demon and it was agreed between him and the citizens that they should send one man every day for his meals. One day, it was the turn of that Brahmin to send a man to the demon. It is in this connection that the verse is written.

एकैकश्चापि पुरुषस्तत्प्रयच्छति भोजनं ।। स वारो बहुभिर्वर्षैर्भवत्यसुकरो नरैः ।।७।।

आदिपर्व, अ. १६०.

The word 'Vāra' has been used to denote the turn (of a day). It has already been pointed out that the word 'Vāsara' occurs in the Rigveda. It shows that the term 'Vāsara' or 'Vāra' used to be applied to a day to show a 'turn', before the names of seven days of a week came into vogue.

Nakṣatras

A complete list of 27 nakṣatras is found given at two places (*see* Chap. 64 and 89, Anuśāsana Parva) but the list begins with Kṛttikās ; names of nakṣatras are found at several places. It is not necessary to quote all the concerning verses here ; but the author gives below only those few sentences which are worth noting.

The references about Mṛgaśiras comes at some places in stories about god Rudra chasing the Mṛga (the star-deer) *e.g.* (*See* verse 20, Chap. 278, Vana Parva).

अन्वधावन् मृगं रामो रुद्रस्तारामृगं यथा ।।२०।।

वनपर्व, अ. २७८.

The story of Rudra chasing the deer (Mṛgaśiras) is found in many Sanskrit works and in Sauptik Parva and also in Chap. 283 on 'Mokṣadharma', in Śānti Parva. For this, read

ततो दैवयुगेतीते देवा वै समकल्पयन् ।। यज्ञं वेदप्रमाणेन विधिवद्यष्टुमीप्सवः ।।१।।

ततः स यज्ञं विव्याध रौद्रेण हृदि पत्रिणा ।। अपक्रांतस्ततो यज्ञो मृगो भूत्वा स पावकः ।।१३।।

स तु तेनैव रूपेण दिवं प्राप्य व्यराजत ।। अन्वीयमानो रुद्रेण युधिष्ठिर नभःस्थले ।।१४।।

अध्या. १८.

In the following verses are to be found references about the Punarvasu stars in which the beauty of the twin stars on both sides of the moon is described.

तावुभौ धर्मराजस्य प्रवीरौ परिपार्श्वतः ।। रथाभ्याशे चकाशेते चंद्रस्येव पुनर्वसू ।।२८।।

कर्णपर्व, अ. ४६.

A reference to star Hasta composed of 5 stars occurs in

पंचभिर्भ्रातृभिः पार्थैर्द्रोणः परिधतो बभौ ।। पंचतारेण संयुक्तः सावित्रेणेव चंद्रमाः ।।३०।।

आदिपर्व, अ. १३५.

The Viśākhā* is said to have two stars.

A reference is found in the following lines.

क्षितावपि भ्राजति तत् (कस्यचिद्राज्ञो मुखं) सकुंडलं ।। विशाखयोर्मध्यगतः शशी यथा ।।४८।।

कर्णपर्व, अ. २१.

Other Stars

A reference to dog star Sirius has already come along with Mṛga. The names of stars other than 27 standard ones are also found in the Mahābhārata *e.g.* in the following lines one gets a reference to Agastya (Canopus) and Saptarṣi with Arundhatī (Great Bear).

सप्तर्षीन् पृष्ठतः कृत्वा युध्येयुरचला इव ।।१६।।

शांतिपर्व, राजधर्म अ. १००

अत्र ते ऋषयः सप्त देवी चारुंधती तथा ।।१४।।

उद्योगपर्व. अ. १११

अगस्त्याशास्तां च दिशां प्रयाताः स्म जनार्दन ।।४४।।

उद्योगपर्व. अ. १४३

Yogas, Karaṇas and Names of 12 Rāśis

Nowhere in the Mahābhārata is found a single reference to Yoga, Karaṇa, or Rāśi. Had Rāśis been in vogue at any stage of the Mahābhārata's compilation, they would certainly have come in the text. This definitely shows that the terms Aries (Meṣa), Tauras (Vṛṣabha) etc. were not current in the age when the Mahābhārata was compiled. In the same way it was not the system to mention a planet's position with reference to a part after dividing the ecliptic into 12 parts. Everywhere in the Mahābhārata we find the position of the moon and other planets with reference to stars.

Solar Months

The sun's position in the ecliptic does not appear to have been given anywhere in the Mahābhārata, still it can be said that like Vedāṅga Jyotiṣa, the solar months were known to the Mahābhārata also; not only that, we also get references of 8 'saṃkrāntis' in the following verse in which their importance as being very auspicious for charity are stated.

पर्वसु द्विगुणं दानमृतौ दशगुणं भवेत् ।।२४।। अयने विषुवे चैव षडशीतिमुखेषु च ।।

चंद्रसूर्योपरागे च दत्तमक्षयमुच्यते ।।२५।।

वनपर्व. अ. २००

The terms 'two ayanas' occurring in it are known in astronomical works as Makara and Karka Saṃkrāntis, and the 'Viṣuvas' are termed Meṣa and Tulā Saṃkrāntis.

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* Some books on astronomy describe Viśākhā as a cluster of 4 stars. Of these, the star Alpha and Beta Libra are very luminous ; but even these stars fade when the full moon comes in between them. If however, the moon happens to come in between these stars any day prior to the 5th tithi of light half or after the 10th tithi of dark half, the scene is very a scinating. (See P. 37, second edition, Jyotirvilāsa.)

The term 'Ṣaḍaśīti' in the Sūrya-Siddhānta applies for the four signs, Gemini, Virgo, Sagittarius and Pisces. This term is used in the plural and therefore, the author feels that it signifies the above mentioned four signs. This consideration leads one to infer that so far as stating the sun's position was considered, the ecliptic was divided into 12 portions at the time of the Mahābhārata.

Eclipses

Ordinary references of solar and lunar eclipses are found at many places. We find the description of fruitfulness of performing Śrāddha ceremonies, at the times of eclipses (particularly at the time of solar eclipses) and of giving away of lands and other articles in charity. Similarly, we get references of occasions when eclipses took place. For instance, a solar eclipse occurred when the Pāṇḍavas started for exile.

राहुरग्रसदादित्यमपर्वणिविशांपते ॥१६॥

सभापर्व. अ. ७६

When the sage Vyāsa met King Dhṛtaraṣtra (before the commencement of the battle) with a view to giving him proper advice, he is said to have uttered the following words.

अलक्ष्यः प्रभया हीनः पौर्णमासीं च कार्तिकीं ॥ चंद्रोभूदग्निवर्णश्च पद्मवर्णे नभस्तले ॥

भीष्मपर्व. अ. २

चतुर्दशीं पंचदशीं भूतपूर्वां तु षोडशीं ॥ इमां तु नाभिजानेहममावास्यां त्रयोदशीं ॥
चंद्रसूर्यावुभौ ग्रस्तावेकमासीं त्रयोदशीं ॥३२॥

भीष्मपर्व. अ. ३

These lines and the previous context show that a lunar eclipse had taken place on the Kārtika-full moon and a solar eclipse had fallen on the next new-moon day. The falling of two eclipses in the same month is a common experience : but those two are rarely seen at the same one place ; and that is why this is regarded as an ominous incident. This phenomenon is considered at lenghth by Bhaṭotpala (in Śaka 888) in his commentary on Bṛhat Saṃhitā (*see* Chapter on 'Rāhucāra').

Viśvaghasra Pakṣa

The above lines contain a reference of a 'Pakṣa'* consisting of 13 days having occurred at the time of the Bhārata battle. The occurrence of a "half-month" consisting of 13 civil days is a rarity ; and hence it is regarded as an ominous incident. This is called a Kṣaya Pakṣa or a missing half. If calculations are done with the formulae given by the Sūrya Siddhānta and other astronomical works and if true positions of the sun and the moon are taken into account, we do sometimes get a 13-day half-month ; but we can never get it by either adopting the mean motions given by the Vedāṅga Jyotiṣa or even by the mean motions given by modern astronomy ; because the measure of

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*The literal meaning of the word is 'wing' or 'side'. A lunar month is said to have sides or halves viz. the light half and the dark half. This word should not be translated as a "fortnight",

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a half-month according to Vedāṅga Jyotiṣa comes to be 14d. 45gh. $29\frac{1}{31}$ p. and that according to S. S. and European astronomical works it comes to 14d. 45gh. $55\frac{3}{50}$ p. The 13-day half-month is possible when its mean value would be less than 14 days. This is never possible if mean values are taken for the motions of the sun and the moon ; but it is possible if true positions are reckoned. For example, the dark half of Phālguna, Śaka 1793 and the light half of Jyaiṣṭha, Śaka 1800 were 13-day half-months. On both these occasions the Grahalāghava almanac and the Keropant's almanac (which took figures from English Nautical Almanac) gave a half-month a measure which was less than 14 days by a few ghaṭis. The occasions when the half-month's measure would be less than 14 days are very few and it is not necessary that a 13-day half-month would emerge on all these occasions. For example, suppose that on the first day of a month (Meṣa) or on the 1st date of an English Calendar month the new moon or full moon takes place at 4 ghaṭis after sunrise and suppose that by reckoning the true motion, the actual measure of half-month came to be 13 days 55 gh.; then the next lunation will take place (*i.e.* the full moon or the new moon would take place) at the end of 59th ghaṭi on the 14th day. Now, because first Parva-end occurred on the 1st day of the solar or civil month, after sunrise, that civil day would be included in the previous half-month and hence, only 13 days would be left to be reckoned in the next half-month. Taking the same example, if we suppose that the first lunation occurred after 10 ghaṭis after sunrise on the 1st date, the second lunation will occur on the 15th day at 5 ghaṭis after sunrise ; hence, the half-month will consist of 14 civil days and not 13. It is therefore quite clear that a 13-day half-month is never possible if mean motions are adopted and the fact that reference of such a half-month occurs in the above lines, leads one to infer that the Indians knew how to calculate true positions of planets even so early as in the Mahābhārata age; and this is a very important thing to note. Some one is likely to raise a doubt that the reference of a 13-day half-month in the Mahābhārata is an actual phenomenon recorded by actually counting the number of civil days elapsed between one lunation to the other after seeing the moon's position in the sky every night and not as a result of calculations based on mean or true motions of planets. This is simply an impossibility. A 13-day half-month is possible (as is shown above) only when the ending moments of new or full moons are about a few ghaṭis before or after sunrise. The moon is never visible on a new moon day, and it is doubtful if it is visible when the ending moments occur near about sunrise. A calm consideration of the problem will convince one that the possibility of such a missing half-month is noticeable not by observation of moon's position by actual mathematical calculation. It is difficult to explain the thing more clearly and in shorter terms.

The above references show that the lunar eclipse had fallen on the Kārtikī full moon day and solar eclipse on the next following new moon day. Now, when a 13-day half-month is the light half of a month, the beginning eclipse must be solar and the ending one a lunar as can be seen from such a half-month *viz.* Vaiśākha Śukla pakṣa of current year (*i.e.* Śaka 1817). But, if a 13-day half-month is to be taken as a dark half of a month, the falling of a lunar eclipse in the beginning and that of a solar eclipse at the end is an impossibility. One will not find such an example in any of the past almanacs. Even if it be supposed that such a half-month did occur, maximum length of it would be 13 days 30 ghaṭis ; but the max-length of actual 'any 13 consecutive civil days' can never be less than 13 days 50 ghaṭis. According to modern accurate

elements, it is not possible to get a 13-day half-month which has a lunar eclipse in the beginning and a solar eclipse at the end ; but we do get such a reference in the Mahābhārata; and one cannot get the occurrence of this phenomenon by adopting mean motions of the luminaries. We are, therefore, led to believe that in the days of 'Pāṇḍava's the Indians had,no doubt, acquired the knowledge of calculating true places of planets, but their calculations were different from (*i.e.* less accurate than) what are done in the present times.

The Mahābhārata relates the occurrence of a solar eclipse when Duryodhana was killed.

राहुश्चाग्रसदादित्यमपर्वणि विशांपते ॥१०॥ गदाप. अ. २७.

A solar eclipse had already occurred one month before the commencement of the battle. Another solar eclipse could not have, therefore, fallen immediately after a month. This appears to be an exaggeration*. It is definitely stated at least in this verse that eclipse had fallen even when it was not a 'parva-day'.

It is probable that occurrence of a 13-day half-month and that of a solar eclipse are exaggerations. Even then we can not say that the phenomenon of the occurrence of a 13-day half-month was not known to people in those times, and the above discussion does not come in the way of our inference.

Planets

Now let us see what references we get about planets in the Mahābhārata. One comes across the following lines in a passage describing the god Sun :—

सोमो बृहस्पतिः शुक्रो बुधोंगारक एवच ॥१७॥ इंद्रो विवस्वान् दीप्तांशुः शुचिः षौरिः शनैश्चरः ॥

वनपर्व. अ. ३.

In this we read of names of Mercury and other 4 planets. The following verse appears to state that the sun had five planets :

ते तु क्रुद्धा महेष्वासा द्रौपदेयाः प्रहारिणः॥ राक्षसं दुद्रुवुः संख्ये ग्रहाः पंच रविं यथा ॥३७॥

भीष्मपर्व. अ. १००.

Similarly the verses

प्रजासंहरणे राजन् सोमं सप्त ग्रहा इव ॥२२॥ द्रोणपर्व. अ. ३७.

निःसरंतो व्यदृश्यंत सूर्यात्सप्त महाग्रहाः ॥४॥ कर्णपर्व. अ. ३७.

refer to 7 planets 'afflicting' the moon. The number seven must, therefore, be including Rāhu and Ketu which are not visible. This shows that our astronomers had developed a knowledge of Rāhu and Ketu with reference to the moon's latitude or the eclipses and that they understood the theory underlying these phenomena.

*The same line occurs at another place as "Rahunarko grasitah.....................etc.". The incident of Duryodhana's death is given in a poetic and figurative way by the writer. He means to say that it was not the death of King Duryodhana but the 'devouring' of the god Sun by Rāhu, on a day (to-day) which is not a parva day. Eclipse is never possible on a non-lunation day. But the poet compares the event of Duryodhana's death with the occurrence of a solar eclipse even when the day was a non-parva day.

R. V. Vaidya

Many people try to suggest that the current names of some planets which occur in Indian astronomy are not originally Indian but of foreign origin, but their names as given by the Mahābhārata are strictly of Sanskrit in origin.

Retrograde Motion of Planets

References about planets' retrograde motion occur at good many places; *e.g.* see the following verses.

लोकत्रास करावास्तां [द्रौण्यर्जुनौ] विमार्गस्थौ ग्रहाविव ॥२॥

कर्णपर्व. अ. १८.

प्रत्यागत्य पुनर्जिष्णुर्जघ्ने संसप्तकान् बहून् ॥ वक्रातिवक्रगमनादंगारक इव ग्रहः ॥१॥

कर्णपर्व. अ. २०.

त्रेता द्वापरयोः संधौ तदा दैवविधिक्रमात् ॥१३॥ न ववर्ष सहस्राक्षः प्रतिलोमोभवद्गुरुः ॥१५॥

शांतिपर्व. आपद्ध अ. ११.

Planetary Conjunctions

We come across references of planets' mutual fights *i.e.* their conjunctions at many places; *e.g. see* the verses.

ततः समभवद्युद्धं शुक्रांगिरसवर्चसोः [द्रौण्यर्जुनयोः] ॥ नक्षत्रमभितो व्योम्नि शुक्रांगिरसयोरिव ॥१॥

कर्णपर्व. अ. १८.

भृगुसूनुधरापुत्रौ शशिजेन समन्वितौ ॥१८॥

शल्यपर्व. अ. ११.

Positions of Planets at the Time of Bhārata Battle

The author gives below the positions of planets as described by the Mahābhārata. These refer to a period two months prior to the commencement of the battle or even the fighting period. When Lord Kṛṣṇa, who had gone to Kauravas on or about Kārtika Śukla 12 for mediation, returned from his mission, on the 7th day before next new moon, he was met by Karṇa who says to him :—

प्राजापत्यं हि नक्षत्रं ग्रहस्तीक्ष्णो महाद्युतिः ॥ शनैश्चरः पीडयति पीडयन् प्राणिनोधिकं ॥८॥
कृत्वा चांगारको वक्रं ज्येष्ठायां मधुसूदन ॥ अनुराधां प्रार्थयते मैत्रं संगमयन्निव ॥९॥
विशेषण हि वार्ष्णेय चित्रां पीडयते ग्रहः ॥१०॥ सोमस्य लक्ष्म व्यावृत्तं राहूरक मुपैति च ॥

उद्योगपर्व. अ. १४३.

These verses describe Karṇa's views about indications of bad omens and loss of general life on a large scale. Similarly, sage Vyāsa is describing in Chapter 3 of *Bhīṣma Parva*, planetary positions which give indications of wholesale destruction of public life. See verses 12 to 18 and 27.

श्वेतो ग्रहस्तथा चित्रां समतिक्रम्य तिष्ठति॥१२॥ धूमकेतुर्महाघोरः पुष्यं चाक्रम्य तिष्ठति ॥१३॥
मघास्वंगारको वक्रं श्रवणे च बृहस्पतिः ॥ भगं नक्षत्रमाक्रम्य सूर्यपुत्रेण पीड्यते ॥१४॥
शक्रः प्रोष्ठपदे पूर्वे समारुह्य विरोचते ॥१५॥
रोहिणीं पीडयत्येवमुभौ च शशिभास्करौ ॥ चित्रास्वात्यंतरे चैव विष्टितः पुरुषः ग्रहः ॥१७॥
वक्रानवक्रं कृत्वा च श्रवणं पावकप्रभः ॥ ब्रह्मराशिं समावृत्य लोहितांगो व्यवस्थितः ॥१८॥
संवत्सरस्थायिनौ च ग्रहौ प्रज्वलितावुभौ ॥ विशाखायाः समीपस्थौ बृहस्पतिशनैश्चरौ ॥२७॥

Knowledge About Planets

It has already been shown on page 108 that the position of planets described by Vyāsa in a dialogue between Karṇa and Kṛṣṇa is a record of observed phenomena in Pāṇḍavas' time, the information having been handed down from generation to generation till it was incorporated in the Mahābhārata. This shows that people in Pāṇḍavas' time, whatever that time be, were well acquainted with the planets and their movements and that the planetary positions used to be stated with reference to nakṣatras.

Pāṇḍavas' Time

Let us now take for consideration the problem of finding the time when Pāṇḍavas lived.

We come across some lines in the Mahābhārata which suggest that Pāṇḍavas lived in the 'transition' period between Dvāpara and Kali,

श्रंतरे चैव संप्राप्ते कलिद्वापरयोरभूत् ॥ स्यमंतपंचके युद्धं कुरुपांडवसेनयो : ॥१३॥

आदिपर्व. अध्याय २.

Similarly, Māruti says to Bhīma,

एतत्कलियुगं नाम अचिराद्यत्प्रवर्तते ॥३८॥

वनपर्व.अ.१४९.

or Yudhiṣṭhira observes while in exile,

अस्मिन् कलियुगे त्वस्ति पुनः कौतूहलं मम ॥ यदा सूर्यश्च चंद्रश्च तथा तिष्यबृहस्पती ॥९०॥
एकराशौ समेष्यंति प्रपत्स्यति तदा कृतं ॥९१॥

वनपर्व. अ. १९०.

or Śrī Kṛṣṇa says to Balarāma after Duryodhana was killed,

प्राप्तं कलियुगं विद्धि प्रतिज्ञां पांडवस्य च ॥ आनृण्यं यातु वैरस्य प्रतिज्ञायाश्च पांडवः ॥२३॥

गदापर्व. अ. ३१.

We also come across a description of time units given in Chap. 188 of Vanaparva, in which are foretold a number of things to happen in (future) Kali. All these references unanimously mean today that according to the Mahābhārata the Pāṇḍavas flourished in the period transitting between Dvāpara and Kali. In the opinion of all astronomical works the Kaliyuga commenced 3179 years before Śaka era ; this shows that in the current year Śaka 1817, the number of Kali years elapsed is equal to 3179+1817=4996. This means that about 5000 years have passed since Pāṇḍavas lived. All astronomical works unanimously agree to when Kaliyuga set in ; and all these works have been written 2600 years after. But we do not find any reliable references in the several works compiled during the Vedic and Vedāṅga Jyotiṣa period, on the basis of which we could fix up the time of Kali-beginning. European scholars however think that the moment of commencement of Kali has been arbitrarily decided by the astronomical works on the basis of certain planetary positions and this view is worth consideration and will be considered later on. If the time of starting Kali era be a correct one and if the Pāṇḍavas really flourished between Dvāpara and Kali, they must have lived about 3200 years before Śaka.

Famous astronomer Āryabhaṭa (Śaka 421) has stated in definite terms that the Bhārata battle was fought in the ending period of Dvāpara (*See* description of Āryabhaṭa, Part II) and it can be proved from his work that 3179 years of Kali had elapsed at the beginning of Śaka era.

Varāhamihira (Śaka 427) says,

आसन्मघासु मुनयः शासति पृथ्वीं युधिष्ठिरे नृपतौ ॥
षट्द्विकपंचद्वि (२५२६) युतः शककालस्तस्य राज्ञश्च ॥

बृहत्संहिता, सप्तर्षिचार.

"The sages (*i.e.* Saptarṣi stars) occupied the Maghā constellation when the King Yudhiṣṭhira ruled the earth ; the year of his reign can be obtained by adding 2526 years to the number of Śaka years elapsed."

This shows that according to Varāhamihira, Pāṇḍavas lived 2526 years before Śaka era *i.e.* after 653 Kali-years had elapsed ; and he has described the movement of Saptarṣi according to Vṛddha Garga's opinion.

The sage Vṛddha Garga also appears to hold the same view. The history of Kashmir, by name Rāja Taraṅginī, has been written by Kalhaṇa, who lived 700 years after Varāhamihira. He has also given in the first chapter (Ullāsa) the time of Pāṇḍavas as 653 Kali-elapsed.

This time quoted by Garga and Varāha is simply an imaginary one. Varāha has stated in the chapter on Saptarṣicāra that these seven stars have motion and they stay in each nakṣatra for 100 years, and the Pāṇḍavas' time has been calculated on this basis ; but it is a fact that the Great Bear is almost stationary and is still on the meridian passing through Maghās just as it did in Yudhiṣṭhira's time. Hence if, the supposition that the 7-stars remain in each nakṣatra for 100 years be regarded as true, then Yudhiṣṭhira will have to be taken as having lived 2700 years or 5400 years (or some other multiple of 2700 years) ago from now. But, the stars have no motion, and hence the time calculated on this assumption has no meaning and so also the time given by Garga and Varāha is meaningless. This sage Garga flourished a century or two after Śaka era started. He noticed the Great Bear to be on a meridian passing near about the constellation of Maghā and hence he must have decided that 2526 years before Śaka elasped after Yudhiṣṭhira lived. This big constellation occupies an extensive region of the sky and the stars could be said to be on a meridian passing through any of the constellations, Maghā to Citrā. The same was their position in Garga-Varāha's time. (If some would tell the author that the Saptarṣis were formerly seen in the 'lune' occupying Maghās and if he thinks them to be in a 'lune' occupying 'Pūrvā', he would naturally be led to believe that the Saptarṣis have got motion). Varāhamihira lived only a few centuries (two or three hundred years) after Garga; hence he also believed as true what Garga stated. In any case the time is imaginary.

The Mahābhārata states that Pāṇḍavas lived at the end of Dvāparayuga, and this view was considered as correct even up to Varāha's time. Āryabhaṭa I who lived before Varāha (or was just his contemporary) accepts this view, but astronomers like Varāha and Garga do not ; this leads one to feel that the Mahābhārata's statement is unreliable.

Shri Visaji Raghunath Lele has published in a news-paper in Śaka 180 his findings about Pāṇḍavas' time based on the planetary positions given in the Mahābhārata. Let us examine the case.

The summary of what Mr. Lele means to say is as follows :—

The dialogue between Karṇa and Vyāsa shows some planets to be positioned on two nakṣatras each. Moon also is stated to be seen with two nakṣatras. The moon's position on the first day of fight is stated in the following verse.

मघाविषयगः सोमस्तद्दिनं प्रत्यपद्यत ॥ २ ॥

भीष्मपर्व. अ. १७.

When Balarāma returned from pilgrimage, it was the 18th day of the battle. He remarked

चत्वारिंशदहान्यद्य द्वे च मे निःसृतस्य वै ॥ पुष्येण संप्रयातोस्मि श्रवणे पुनरागतः ॥ ६ ॥

This shows that the nakṣatra on the first day of the battle must have been either Rohiṇī or Mṛga. Thus according to the Mahābhārata, the planetary positions were observed on two different nakṣatras as given below :—

Moon : situated in (i) Rohiṇī or Mṛga and (ii) Maghā

Mars : „ (i) Maghā and (ii) Anurādhā or Jyeṣṭhā

Jupiter. : situated near (i) Viśākhā and in (ii) Śravaṇa

This shows that one nakṣatra seems to be 'divisional and Sāyana' and another one a 'stellar and nirayaṇa.' These two nakṣatras, in each case differ by 7 or 8 nakṣatras. Calculating the possible age when so much difference in Sāyana and Nirayaṇa nakṣatras could have happened, we get 5306th year before Śaka era (or 2127th year before Kali era). The battle appears to have been fought in the Sāyana month of Mārgaśīrṣa of that year. The planetary position described in the dialogue of Karṇa and Vyāsa refers to the period of 22 days before this. The author calculated planets' places on the Kārtika new moon day by Keropant's planetary tables. This book has accepted the Sūrya Siddhānta's measure for a year. The moment of equinox according to this measure comes to be 12^{gh} 27^{p} after mean sunrise on Saturday, the eleventh tithi of Caitra Śukla pakṣa of that year. The tropical true longitude of the sun comes to be 8^{s} $25°$ $1'$ which shows that the Caitra is actually the Sāyana-Pauṣa ; and the ayanāṃśa for that year was 3^{s} $4°$ $59'$. Adding this to Sāyana longitude of the planet we get its Nirayaṇa place. The new moon of Nirayaṇa Māgha is found to occur 313 days after the vernal equinox in that year. The Sāyana positions of planets, at 12^{gh} 27^{p} after mean sunrise at Bombay, come to be as given below :—

Planet.	Trop. long. s	°	′	Sāyana Nakṣatra.	Nirayaṇa Nakṣatra.
Sun	7	3	16	Viśākhā	Śatabhiṣak
Moon	7	3	27	Anurādhā	„
Mercury	7	1	8	Viśākhā	Dhaniṣṭhā
Venus	7	21	1	Jyeṣṭhā	P. Bhādrapadā
Mars	4	6	34	Maghā	Anurādhā
Jupiter	6	17	47	Svātī	Śravaṇa
Saturn	6	1	8	Citrā	U. Bhādrapadā
Rāhu	7	10	43	Anurādhā	Śatabhiṣak
The moon's approx. long. (on next full moon day)	1	18		Rohiṇī	P. Phalgunī

Mars is said to be in Maghā ; by calculation it appears to be Sāyana Maghā. Jupiter and Saturn are stated to be near about Visākhā ; and calculation shows Jupiter to be in Sāyana Svātī and Saturn in Sāyana Citrā. The nirayaṇa system was not at all in vogue in Pāṇḍavas' time. The position of a planet used to be given as "situated in such and such sāyana division and near such and such star" ; and according to this system Mars was given to be near the fixed star Jyeṣṭhā (Alpha Antares). The fixed stars were and even now are situated somewhere near about the nirayaṇa divisional nakṣatra of that name. According to that system, the star Jyeṣṭhā was situated in the nirayaṇa Anurādhā* division and Mars conjoined with the star. The statement "*aṅgārakaḥ jyeṣṭhāyāṃ vakraṃ kṛtvā*" of the verse should not be interpreted as the retrograde motion of Mars, but its motion "away from" the star Jyeṣṭhā as far as the latitude was concerned. Jupiter has been said to be near Śravaṇa, so we find it near Śravaṇa star by calculation. The moon has been given to be near Rohiṇī and so we find her position by calculation. Its position near Maghā is confirmed by calculation which shows her to have been near Maghā-star in the nirayaṇa Pūrva-Phalgunī division. Venus proves to be near P. Bhādrapadā as told by the Mahābhārata. The words "*Rāhuḥ arkaṃ upaiti*" meaning "Rāhu comes near the Sun" is found to be true by calculation. In short, the planetary positions described by the Mahābhārata appear to be given in terms of Sāyana divisional nakṣatras and actual stars, and the year of battle comes to be 5306th year before Śaka era. This is the gist of what Mr. Lele has published. The following are some serious objections against his statement :—

(1) Mr. Lele states that the planetary positions given by the Mahābhārata are Sāyana ; but they are not so. The zodiac in the present time is taken to commence from Aśvinī; following the same principle, Mr. Lele has converted the positions of all planets with regard to the equinox, taking first nakṣatra from this as Aśvinī. But whence does he get the rule of regarding first nakṣatra from equinox as Aśvinī? Sāyana-Aśvinī-nakṣatra is not a visible star. It is quite obvious that originally the divisional nakṣatras began to be known by the names of some visible stars ; and hence, the sāyana nakṣatra in which the equinox used to take place in the time of Pāṇḍavas must have got the name of that star which was actually situated in the division. But Mr. Lele says that the nakṣatras in the time of the Mahābhārata were sāyana and commenced from Aśvinī. These arguments would lead one to infer that the system of reckoning sāyana Aśvinī as the first nakṣatra must have come into vogue at a time when the equinox used to occur near about Aśvinī star. By calculation we find that the equinox used to take place near a star of Arietis group in between Śaka 500 to 800 but the Pāṇḍavas lived long before this period. Hence, according to Mr. Lele's view, the Sāyana-Aśvinyādi system was in vogue about 26000 (or an integral multiple of 26000) years before Śaka era. But we do not come across names of nakṣatras as begun from Aśvinī; we get references of the nakṣatra cycle beginning from Kṛttikās or from Dhaniṣṭhā or even from Śravaṇa. Not only this, but in the Vedas we do not get a single reference of 'Aśvinyādi' system, even in the Vedāṅga-Jyotiṣa we do not read of Aṣvinyādi' system, but of Dhaniṣṭhādi; and the list of controlling deities begins with Kṛttikās. In the Rigveda we no doubt get a solitary reference of Aṣvinī being the first nakṣatra, but it has been shown on page 72 that the

*The Nirayaṇa divisional nakṣatras, shown in the above table are not given by Mr. Lele ; it is the author who has noted them for a clear understanding of what he wanted to say by stating that such and such planet was near a particular star.

reason is quite a different one. Aśvinī was never the first nakṣatra before 500 years before Śaka (i.e. before about 2300 years from now). The current astronomical works do treat of the Aśvinyādi system, and those of the works which describe them are not older than 2300 years. This will be proved later on. In no works belonging to the Vedic or the Vedāñga Jyotiṣa period, do we find either any reference of Meṣa and other Rāśis nor of 'Aśvinyādi nakṣatras'.

(2) If any one says that the sāyana system of planetary reckoning commenced when the equinox was in Kṛttikās and that the time when Pāṇḍavas lived could be found, by supposing that the astronomical references given by the Mahābhārata are sāyana and the sāyana-divisional Kṛttikā nakṣatra commenced from the equinoctial point, then his suggestion can be accepted. The dual position of planets given by the Mahābhārata refers to two nakṣatras which are separated by seven or eight nakṣatras. Hence, adopting the Aśvinyādi system we get position of equinox in Punarvasu in Pāṇḍavas' time ; and such was the equinoctial position in the 5306th year before Śaka era. If we start with the assumption that in the time of Pāṇḍavas the system was Kṛttikādi, even then the references of planetary positions can be shown to be true ; only the Pāṇḍavas' time would prove to be 2000 years earlier i.e. about 7300 years before Śaka. The equinox occurred in Kṛttikās about 2400 years before Śaka. The Pāṇḍavas lived before this date. Hence, Mr. Lele will have to say that "The Kṛttikādi-system of nakṣatra reckoning started 26000 years before '2400 years before Śaka' i.e. about 28000 years before Śaka and therefore, also that it continued for 21000 years up to Pāṇḍavas' time."

But acceptance of the statement that the sāyana system of calculation began 26 or 28 thousand years before Śaka era involves the responsibility of proving that our astronomers were well-versed in the knowledge of huge astronomical figures involved in necessary calculations for almanac-making. Only the almanac makers can understand the implications of such assumptions and it cannot be agreed to. Mr. Lele ovserves that our people possessed up-to-date knowledge of astronomy since 26000 years before Saka or even before that date, they could record correct observations and that the works written in those old ages are now lost*. How could the system which continued for 25000 years suddenly lapse ? How could all the works written in this period be lost and the whole knowledge of astronomy be forgotten ? The history of hundreds of books on astronomy written during the last 2000 years are traceable from one to the other correctly. (This will be shown in the next part.) Under such circumstances, how is it that not a single work of the old period is available and no trace of the previous mathematics obtainable. Books written 500 years before Śaka are available but none of them contain any trace of the accurate astronomical calculations. Mr. Lele will have to accept that the Vedic and the Vedāñga Jyotiṣa literature belonged to the pre-Pāṇḍava-period. It is, therefore, impossible to solve the puzzle how the astronomical works and astronomical knowledge possessed by the people in the intermediate period were lost when the works written in the Pāṇḍava and the Vedic periods are still available.

Mr. Lele has taken the Aśvinī as the first nakṣatra ; it is not so mentioned in any of the Vedic works ; and it is most improbable that people of that time completely understood the delicate implications of the conception of sāyana and nirayaṇa systems to be followed in astronomical calculations.

*The ideas expressed by the author in the above 2 or 3 paragraphs are the views expressed by Mr. Lele to him privately in a letter dated 21st May, 1895.

This stand could be proved as unjustified from many evidences. The positions of planets given by the Mahābhārata are, therefore, not sāyana and hence, the time calculated on the basis of that assumption is also not correct.

In addition to the two major objections raised against the assumption *viz.* that the planetary positions described by the Mahābhārata are sāyana some more minor objections could be brought against it :— ..

(3) The Mahābhārata states that Jupiter and Saturn were seen near "Viśākhā". Mr. Lele, after interpreting Viśākhā as a "sāyana-divisional nakṣātra" has shown by calculation that Jupiter had occupied the sāyana Svātī division and Saturn the sāyana Citrā division and on that account they could be said to be near Viśākhā. Now, sāyana Viśākhā is not a star but a division ; where, then, was the need of saying that "Jupiter and Saturn were found to be near Viśākhā", when they were respectively in the Svātī and Citrā divisions ? They could have been stated to be in these starry divisions in clear words.

(4) The planetary position when Karṇa was killed is given in verse No. 6 :—

बृहस्पतिः संपरिवार्य रोहिणीं बभूव चंद्रार्कसमों बिशांपते ॥ ६ ॥

In this Jupiter has been stated to be stationary near Rohiṇī *which does not move.* (i.e. Rohiṇī is not regarded as sāyana).

(5) Saturn is stated to be 'afflicting' Rohiṇī and also the Bhaga (i.e. Phalgunī) nakṣatra. Mr. Lele has not considered these statements. This reference can be interpreted as one planet while conjoining with one nakṣatra 'afflicts' another, and 'Sūryaputra' can for the sake of satisfaction, be interpreted, not as Saturn, but as one of the comets in the solar system.

(6) Mr. Lele has not been able satisfactorily to explain how Mars (Pāvaka-prabha-lohitāṅga stated in the verse Vakrānuvakram) was *'retrograde and then direct'*. He is required to interprete it, not as Mars but as some comet. In short, the position of some planets stated to be on more than two nakṣatras can not be satisfactorily explained by regarding the nakṣatras as sāyana divisions.

(7) The nakṣatras, referred to in the verse "*Maghāsvaṅgārako vakraḥ Śravaṇe ca Bṛhaspatiḥ*" must both be of the same one system ; but Mr. Lele regards Maghā as sāyana and Śravaṇa as nirayaṇa. It is also interesting to note that 'Maghā' has been used in plural. How can a sāyana division be expressed in plural form ?

(8) The planetary positions in the early morning of the day on which Śalya was killed are described in the line

भृगुसूनुधरापुत्रौ शशिजेन समन्वितौ ॥ १८ ॥

शल्यपर्व, अ. ११.

This verse states that Venus, Mars and Mercury were together on that day. Mr. Lele's calculations do not explain and support the statement.

(9) Mars is stated to be 'offering prayers' to Anurādhā after 'turning round Jyeṣṭhā'. The retrograde motion of Mars is clearly shown here. As the calculations did not prove the motion of Mars as retrograde, Mr. Lele was required to interprete the word 'vakra' as otherwise.

(10) Accepting Mr. Lele's ayanāṁśas as true, if we convert the tropical longitudes of planets into nirayaṇa nakṣatras, we get the moon's position to be in P. Phalgunī and not 'near Maghā' as stated in the Mahābhārata ; Mars

is found to be in nirayaṇa Anurādhā ; and Mr. Lele regards it to be 'near Jyeṣṭhā' as stated by the Mahābhārata. He also states that in the Mahābhārata age the planetary positions were not given in terms of nirayaṇa nakṣatras but near some stars. Let us, therefore, find out the stars near which the planets in the year 5306 before Śaka, actually were. If accepting the annual precessional motion to be 50″ the tropical longitudes of stars for the abovementioned year be calculated we get the longitude of the junction star of P. Bhādrapadās as 8ˢ 13° 5′. Venus was 22° to its west *i.e.* even west of star Śatabhiṣak. Would it look well if we say that it was near P. Bhādrapadā ?

The longitude of Jyeṣṭhā was 4ˢ 29° 22′ and Mars was 23° to its west that is near the star Viśākhā ; how can it be said to be near Jeyṣṭhā ? Even taking for granted that the actual precessional motion was somewhat different from 50″, and that the stars also have got some motion and that the planetary positions were not given in terms of celestial longitudes but in right ascensions, it will still be found that the actual positions of these two planets do not tally with those given by the Mahābhārata.

It is possible to find some other time which is a bit later or earlier than that suggested by Mr. Lele and then one will not be able to raise the last 2 or 3 objections against it ; still other objections do stand. On the whole it can be said that the planetary positions described by the Mahābhārata are not given with reference to a dual (sāyana and nirayaṇa) system, and that the time suggested by Mr. Lele is not correct*.

Late Shri Venkatesha Bapuji Ketkar interpreted the verse about Saptarṣis that the Yudhiṣṭhira era was in vogue for 2526 years before Vikrama Śaka and hence, he considered that the Pāṇḍavas lived 2526+135=2661 years before Sālivāhana Śaka. On this supposition he maintained that the Māhabhārata battle was fought in the months of Mārgaśīrṣa and Pauṣa of the 2662nd year before Śaka *i.e.* in the year 2585 B.C. from Nov. 8 to Nov. 25 of that year. Taking 1ˢ 13° 57′ as the ayanāṃśa he calculated nirayaṇa positions of planets true for the morning of Thursday, Kārtika new moon day, with the help of Keropant's planetary tables, which are given below :—

Planet	Position			Nakṣatra	Planet	Position			Nakṣatra
	s	°	′			s	°	′	
Sun	7	24	0	...	Venus	7	10	33	Anurādhā
Mars	3	8	30	Puṣya	Saturn	6	7	51	Svātī
Jupiter	7	24	48	Jyeṣṭhā	Rāhu	8	19	39	...

Moon has been calculated for Friday, the Mārgaśīrṣa full moon day. It is found to occupy the Mṛga nakṣatra, the longitude being 1ˢ 27° 30′.

He says that the position of Venus as described by the Mahābhārata in the line "*śveto grahaḥ prajvalito jyeṣṭhāmākramya tiṣṭhati*" is seen to be true by his calculated result. After showing by calculation that there were eclipses in the beginning and at the end of Mārgaśīrṣa, Mr. Ketkar says that Jayadratha was killed at the time of the second eclipse. This event and the planetary positions do not tally with those given in the Mahābhārata**.

*This should not be taken to mean that the sāyana-system is not acceptable to the author. He wants only to say that the planetary positions given by the Mahābhārata are not sāyana. That the sāyana system of position-reckoning was acceptable to the Vedas will be shown in detail later on.

**For objections against Mr. Ketkar's calculations readers are requested to see the May and June 1884 issues of 'Indu Prakśa' and 'Poone Vaibhava' papers.

Pāṇḍavas' time has not been found beyond doubt as yet on the basis of planetary positions given by the Mahābhārata ; but this does not mean that these positions were incorrect. The author believes that the references found in the dialogue between Karṇa and Vyāsa indicate factual position of the planets and that they have been incorporated in the Mahābhārata on the basis of the information handed down direct from Pāṇḍavas' time. It can at most be said that we are unable to establish the agreement. He has seen how one gentleman, Janardan Hari Athalye, has attempted to disprove Mr. Lele's theory and to establish the agreement with the help of nirayaṇa system of astrology. He does not think that Lele has succeeded in his attempt even to some extent. He does not know who will be able to explain the validity of the references of planetary positions.

The names of months, Caitra etc., were in vogue in Pāṇḍavas' time and they could not have belonged to a period earlier than 4000 B.S. (*i.e.* before Śaka*) ; (this will be proved later on). This shows that Pāṇḍavas' time can not be taken to be earlier than 4000 B.S.

By the by, the author notes down the Pāṇḍavas' time as can be established from historical references found in the *Viṣṇu Purāṇa* and the *Śrīmadbhāgavata* :—

महानंदिसुतः शूद्रागर्भोद्भवोऽतिलुब्धो महापद्मो नंदः परशुराम इवापरोऽखिलक्षत्रियांतकारी भविता ॥ ४ ॥ तस्याप्यष्टौ सुताः सुमाल्याद्या भवितारस्तस्य च महापद्मस्यानु पृथ्वीं भोक्ष्यंति । महापद्मस्तु पुत्राश्च एकं वर्षशतमवनीपतयो भविष्यंति । नवैतान्नंदान् कौटिल्यो ब्राह्मणः समुद्धरिष्यति ॥ ६ ॥ तेषामभावे मौर्याश्च पृथ्वीं भोक्ष्यंति । कौटिल्य एवं चंद्रगुप्तं राज्येभिषेक्ष्यति ॥ ७ ॥

यावत्परीक्षितो जन्म यावन्नंदाभिषेचनं । एतद्वर्षसहस्रं तु ज्ञेयं पंचदशोत्तरं ॥३२॥

विष्णुपुराण, अंश ४ अध्या. २४.

These verses describe in a 'future form' the number of years of reign by kings of different dynasties, *e.g.* 1015 years elapsed between the king Parīkṣit (grand son of Yudhiṣṭhira) and the crowning of Nanda. After him 9 Nandas ruled for 100 years, and after them the Emperor Candragupta Maurya (the disciple of Cāṇakya) came to throne. The same story is related in chapters 1 and 2 of 12th section of the Bhāgavata, with the difference that the word 'Śataṃ' is found substituted for 'Jñeyaṃ' which means that from Parīkṣit to Nanda as many as 1115 years passed. When Alexander the Great came to India, Candragupta had gone to see him. He (Candragupta) came to throne at Patna in the year 316 B.C. At the time of Seleucus who was a very strong general of Alexander, Candragupta was known to be a very great king. His grandson was Aśoka and these were well known facts of history beyond controversy.

If the description given by the Viṣṇupurāṇa and the Bhāgavata about the years of reign (*viz.* 1015 or 1115 years) of kings from Parīkṣit to Nanda be correct, we will have to take for Pāṇḍavas' time a year near about 1431 or 1531 B.C. and almost all European scholars accept this time as correct.

*The Śaka era differs from Christian era by only 78 years. The time established by astronomy as being some year before Śaka era is likely to err by 78 years on account of so many reasons. Hence a date given by the author as B.S. may, for practical purposes, be taken even as so many years B.C.

In the author's opinion, the Pāṇḍavas must have lived between 1500 to 3000 B.S. and not earlier than this.

Knowledge of Planetary Motions

When the Mahābhārata was compiled people were possessing reasonable amount of knowledge of planets' motion. The following verse is worth reading.

क्षयं संवत्सराणां च मासानां च क्षयं तथा ॥ ४६ ॥ पक्षक्षयं तथा दृष्ट्वा दिवसानां च संक्षयम् ॥

शांतिपर्व, अ. ३०१, मोक्षधर्म.

In this we find references of lapse of a year, a month, a half-month and of a day. The term 'lapse of a day' occurs in Vedāṅga Jyotiṣa. The lapse of a half-month occurs in the Mahābhārata at a second place, discussed about in pp. 114-115. In addition to these two, we get a reference of a lapse of a month and lapse of a year. A lapse of one year occurs after every 85 years. (*See* the Udaya-system and mean-Rāśi-system under 'examination of the topic of Saṃvatsara in Part II); but this presupposes the system of describing Jupiter's motion in relation to signs. The Mahābhārata does not contain either Rāśi-terms or the system of indicating planets' place with reference to a 12-part system of an ecliptic. From this it appears that the system of fixing a name to a year from Jupiter's place found by mean-rāśi motion was not in vogue in the Mahābhārata's time. The 12-year cycle system is more ancient than this. It depends upon the heliacal rise and set of Jupiter. By following it the lapse of a Saṃvatsara occurs often. This might have been in vogue in the Mahābhārata's time. If it be supposed that the mean-rāśi system was then in vogue we will have to accept that people had accurate knowledge of Jupiter's mean motion. The 'lapsed month' which occurs in our time can not be accurately found without knowing exact true positions of the sun and the moon. The system of naming months after nakṣatras has been described in Part Two and according to it the lapse of a month does take place ; this shows that the system was known in the Mahābhārata period. From the discussion on 'lapse of a half-month' made before, it will be seen that they did not have accurate knowledge of true motions of the sun and the moon ; but if the rule of making a month, a half-month and a day missing be the same as at present, then we shall have to believe that people in the Mahābhārata time had complete accurate knowledge of the true motions of and of corrections to be applied to the sun and the moon as at present.

Miracles of Nature

In the Mahābhārata we find at many places descriptions about comets and meteors. The following description of the sun as causing rain is worth noting :—

त्वमादायांशुभिस्तेजो निदाघे सर्वदेहिनां ॥ सर्वौषधिरसानां च पुनर्वर्षासु मुंचसि ॥ ४६ ॥

वनपर्व, अ. ३.

At some places we find the moon associated with the tides of ocean ; we get allusions to show their conviction that the earth is round. The following

verse will show that people had observed that the other side of the moon is never visible :—

यथा हिमवतः पार्श्वं पृष्ठं चंद्रमसो यथा ।। न दृष्टपूर्वं मनुजैः

शांतिपर्व, अध्या. २०३ मोक्षधर्म.

These references show that we find among the people a curiosity of finding causes of natural phenomena after observing the miracles on the earth and in the sky.

The Saṃhitā Section

In the Mahābhārata we come across many references about suggestions to do or not to do certain things as per Muhūrta section of Saṃhitā branch of astronomy . It has already been shown above that the planetary positions have been given in the Mahābhārata with a view to describing the probable effects of such positions.

यतो वायुर्यतः सूर्यो यतः शुक्रस्ततो जयः ।। २० ।। एवं संचिंत्य यो याति तिथिनक्षत्र-पूजितः ।। २५ ।। विजयं लभते नित्यं सेनां सम्यक् प्रयोजयन् ।।

शांतिपर्व, अ. १००.

This has been addressed to Dharma by Bhīṣma. The starting for expedition on Puṣya nakṣatra has been described at many places as being very auspicious. At one place we find mention of a 'Bhaga' nakṣatra as auspicious for marriage. In the Vedas alone we find 'Bhaga' as the deity controlling Uttara Phalgunī ; otherwise we find her as controlling Pūrva Phalgunī. But P. Phalgunī has not been included in the list of nakṣatras devoted to celebration of marriages. The following line refers to Draupadī's marriage with Dharmarāja.

अद्य पौष्यं योगमुपैति चंद्रमाः पाणिं कृष्णायास्त्वं (धर्मराज) गृहाणाद्य पूर्वं ।। ५ ।।

आदिपर्व, अ. १९८.

Because Puṣya is not regarded as a marriage-nakṣatra, Caturdhara, the commentotor, defends the acceptance of this nakṣatra saying "By the word 'Pauṣya' is to be understood that nakṣatra which causes nourishment and not the Puṣya nakṣatra". The author does not agree with the explanation. The next description will show that Draupadī was married to five Pāṇḍavas on five consecutive days ; but in our present day list of marriage-nakṣatras we do not find any five nakṣatras which are consecutive in order.

Summary

Matters of astronomical interest occurring in the Mahābhārata have been so far discussed, some of which are of much impoitance. Even though the terms, Meṣa, Vṛṣa, etc. and the names of week-days are not found in the Mahābhārata, it need not be suspected that these have been borrowed from the Greeks. The author reiterates them as follows :—(1) People had knowledge about planets at the time of Pāṇḍavas, whatever that time may be. No one thinks it was later than 1500 B.S. In any case, it was the time before names of 7 days and names of signs came into use, that is, before our astronomy came in contact with the Greek system. (2) The ecliptic was divided into 12 parts with respect to the sun's position. (3) The reference of a 13-day half-month shows that people had a working knowledge of finding the true positions of

the sun and the moon. (4) If the method of reckoning a missing day, half-month, month and a year was similar to that in the present time, it must be accepted that people in those times had accurate knowledge of the sun's and the moon's true positions and motions and that of mean motions of Jupiter and other planets. (5) People used to observe and think over not only the miracles of the sky, but some planetary phenomena like the rise and set, (both diurnal and heliacal) of planets and their eight-fold motions like direct, retrograde etc.

One can not make definite statements about the above matters from references in the Purāṇas just as have been made from those in the Mahābhārata because one can not say with certainty anything about their time ; and to read through all Purāṇas is a matter of time and hence, the author does not make any observations about them. He has not considered anything about even the Rāmāyaṇa since it does not contain terms like Meṣa etc. It is, however, clear that some of its portions must be belonging to period later than the Vedic or Vedāṅga Jyotiṣa age and some of it must have been written earlier than the Mahābhārata's compilation ; but it is very difficult to make a definite selection of the two portions.

SUMMARY OF PART ONE

The Time of Śatapatha Brāhmaṇa

This part will be summarised after stating some important facts and inferences worth mentioning at this place.

Following lines are found in Śatapatha Brāhmaṇa :—

एकं द्वे त्रीणि चत्वारीति वा अन्यानि नक्षत्राण्यथैता एव भूयिष्ठा यत्कृत्तिकास्तद्भूमानमेवैतदुपैति तस्मात्कृत्तिकास्वादधीत ।।२ ।। एता ह वै प्राच्यै दिशो न च्यवंते सर्वाणि ह वा अन्यानि नक्षत्राणि प्राच्यै दिशश्चयवंते तत्प्राच्यामेवास्यैतद्दिश्याहितौ भवतस्तस्मात्कृत्तिकास्वादधीत ।। ३ ।।

शतपथब्राह्मण, २. १. २.

"Kṛttikās alone consist of many stars, other asterisms (consisting of) one, two, three, or only four stars. (He who performs the agnyādhāna ceremony on this nakṣatra) gets plentifulness (or abundance) of this star ; that is why "fire should be lit" on Kṛttikās. These are the only stars which do not 'deviate' from the east while all others do. He who does the ceremony on this nakṣatra gets two of his 'agnis' *i.e.* fires firmly established in the east, and that is why fire should first be lit on Kṛttikās."

The statement "Kṛttikās never deviate from the east" implies that these stars always rise in the east, that is, they are situated on the Equator or that their declination is zero. At present they do not appear to rise exactly in the east but at a point north of east ; this happens because of precessional motion of the equinox. Assuming 50″ as annual motion, the time when the junction star of the Kṛttikās had zero declination, comes to be 3068 years before Śaka and even 150 years earlier, *i.e.* the approximate time of commencement of Kali era, if 48″ be adopted as the precessional annual motion. Calculating the declination of some other stars in this age, we find that the northernmost star of Rohiṇī group, the southern three of Hasta group, two from Anurādhā, one from Jyeṣṭhā and one from Aśvinī were situated near the Equator ; only some one star from Hasta group (if at all) could possibly have been situated exactly on the Equator, otherwise none.

The statement about Kṛttikā's rising in the east is made in the present tense and they can not always do so because of precessional motion of equinoxes. In our time we find them rising to the north of east and they used to rise to its south in 3100 B.S. From this it can be inferred that the concerning portion in Śatapatha Brāhmaṇa was written about 3100 years before Saka era.

The Time of Kṛttikādi system

The list of nakṣatras mentioned in the Vedas begins with Kṛttikās. The equinox used to occur in the 4th quarter of Bharaṇī division in the Vedāṅga-Jyotiṣa age. It must have been in Kṛttikās before that time ; and assuming that the nakṣatra-list commenced from Kṛttikās, Bentley and other European scholars have found 15th century B.C. as the time when the equinox used to take place in Kṛttikās ; but this is erroneous. The mistake which was committed in the case of Vedāṅga Jyotiṣa has been committed in this case also. The tropical longitude of Kṛttikās must have been zero in the age when equinox used to coincide with this asterism. Its sāyana longitude in 1850 A.D. was 57° 54′. Hence, the time of equinox being in Kṛttikās comes to be (57° 54′ ×72) *i.e.* 4170 yrs—1850=2320 B.C. The scholar Bayo has found out the time of Kṛttikādi system as prevailing amongst the Chinese to be about 2357 B.C.* and he must have found the time by adopting the same system of calculation as followed by the author. He has not read Bayo's original articles ; but it is surprising to see that Bayo has not followed the system in the case of Hindus which he has done in the case of the Chinese-nakṣatra system.

According to Weber, the time of Kṛttikā being first nakṣatra comes to be somewhere between 2780 to 1820 B.C. Dr. Thibbaut has a fairly good knowledge of Indian astronomy. His opinion about this point has recently been published. The gist of his arguments is as follows :—There is no support to show that Kṛttikās were regarded as the first nakṣatra because equinox used to occur in that nakṣatra. We do not come across any description in the Vedic literature about planetary positions signifying a time prior to the one given by the solstitial positions described by Vedāṅga Jyotiṣa. The statement of winter solstice occurring in the beginning of Dhaniṣṭhā nakṣatra is very ambiguous ; because the stars in the nakṣatra division** occupied by the sun is never visible ; it can not be said with certainty at which point of the ecliptic the sun must have been for the occurrence of the winter solstice given by Vedāṅga Jyotiṣa. Hence, the time calculated by the above method is liable to be mistaken even by 1000 years.

The Europeans have not even now understood the quotation from Śatapatha Brāhmaṇa given above. The Pleiades are seen above the horizon for about 10 or 11 months during the year ; and when they used to rise exactly in the east, this eastern rise could be seen from any place on the earth then; and there is nothing to be doubted about this. If there would have been an error of 1 degree in ascertaining the exact astronomical east, that in the calculated time would not be more than 200 years. In short, the reason *why Kṛttikās used to be reckoned as the 1st nakṣatra was their rising in the exact East.* The time for this event was about 3000 B.S. without doubt.

The Vedic Age

The Taittirīya Saṃhitā which is more ancient than Śatapatha Brāhmaṇa also mentions Kṛttikās as the first nakṣatra. Hence, this part of the Saṃhitā

***See translation of S.S. by Burgess.**

****See the 1895, April issue of Indian Antiquary XXIV.**

must have been compiled either in 3000 B.S. or a century or two before. The statement about Kṛttikās being first is unequivocally given in Śatapatha Brāhmaṇa and hence its time is definitely 3000 B.S. or a century or two later. It can be said without doubt that all those sections of the Vedas which quote Kṛttikās as the first nakṣatra must have been compiled a century or two earlier or later than 3000 B.S. The Rigveda Saṃhitā does not mention the Kṛttikādi nakṣatra system ; hence, it must belong to a time earlier than 3000 B.S.

Who was the Originator of the Nakṣatra System ?

Some Europeans maintain that the Vedic nakṣatra system does not belong to the Indians originally. The author thinks there is no country in the world the people of which (however savage they might be) never observed any association of the moon with the stars or have not given any names to them.

If no other evidence can be given to show that the Vedic nakṣatra system belongs to Indians, at least some of the Vedic stories, like the Moon's love to Rohiṇī, can be taken as sufficient evidences. The time when, according to some Europeans, the Hindus appear to have borrowed this system from the Chinese, the Babylonians or other unknown countries, could not have been earlier than 2780 B.C. ; but it has already been shown above that nakṣatras were known to Hindus earlier than 3000 B.C. and that these are mentioned in the Vedic literature even before this time. From this it will appear that the argument, that nakṣatras have been borrowed by Hindus from foreigners, does not stand. If Chinese have established their system independently, then the Hindus also have done the same independently and any impartial thinker will agree with this.

Caitra and Other Names

It has been observed that names of months, Caitra and others are nowhere found in the Vedas ; but they are found in later works of the Brāhmaṇic period. We come across the following line in Śatapatha Brāhmaṇa.

यीऽसौ वैशाखस्यामावास्या तस्यामादधीत...आत्मन्येवंतत्प्रजायां पशुषु प्रतितिष्ठति ॥

श. ब्रा. ११. १. १. ७.

"It is the new moon of Vaisākha...which becomes a source of prosperity to us, to people and to beasts."

Śatapatha Brāhmaṇa consists of two parts comprising 14 sections in all. The first part, known as Pūrva Śatapatha, contains 10 sections (=66 chapters) and the second part, Uttara Śatapatha consists of 4 sections (=34 chapters). The above line occurs in the 11th section ; just before this line we get the line

तस्मान्न नक्षत्र आदधीत ॥

श. ब्रा. ११. १. १. ३.

which means "do not lit fire on the nakṣatra", and it has been ordained in the first part that 'ādhāna' should take place specifically on the nakṣatra. We get a reference of the term '*Vedānta*' at two or three places in the same portion of the 11th section in which the above line occurs and in which the portion of the Vedic literature known as 'Vedānta' containing Upaniṣads also occurs and the 14th section of Śatapatha Brāhmaṇa is devoted to the theory of Vedānta itself; that it is known as Bṛhadāraṇyaka is also well known. It can easily be seen from this that the second part of Śatapatha Brāhmaṇa belongs to a

much later period than the first one; and no objection can be raised if we say that the names, Caitra etc. came into vogue in the latter part of the Brāhmaṇic period. The Kauṣītakī Brāhmaṇa gives the line

तैषस्यामावास्याया एकाह उपरिष्टाद्दीक्षेरन् माघस्य वेत्याहु : ।

कौ. ब्रा. १६. २. ३.

"One should commence a sacrifice after the passing of 'ekāḥa' of the new moon of Pauṣa";

in which we get the terms Taiṣa (*i,e*, Pauṣa) and Māgha. This very line has at its end a sentence which means that winter solstice occurs in the beginning of Māgha. This shows that the time of this Brāhmaṇa (K. Br.) must have been the same (*viz*. 1500 B.S.) as that of Vedāṅga Jyotiṣa. The Pañca Viṃśa Brāhmaṇa gives the following line :—

मुखं वा एतत्संवत्सरस्य यत्फाल्गुन :

पंचविंश ब्रा. ५. ६. ६.

"The month known as Phālguna is the 'month' (*i.e.* the commencing month) of the year".

This refers to the month Phālguna. The whole consideration shows that the names of months, Caitra and others, were never in vogue in the Vedic times, but had come into use, at the end of the Brāhmaṇic period.

The Time when these Terms (Caitra etc,) came into vogue.

Let us consider the problem of finding the time when these names came into use. The sidereal year exceeds the solar year by about 50 palas. Seasons depend upon solar year. The season which would seem to occur to-day when the sun would come to equinox, would seem to occur even after thousands of years when the sun comes to equinox ; but seasons will not be the same for all times to come when the sun comes to the same particular nakṣatra ; a difference of two months (for the occurrence of the same season) will take place after about 4300 years *i.e.* of one month after about 2000 years.* Thus, if the Spring season has been observed to be occurring when the sun comes to Aśvinī, the next season Summer (*i.e.* the Grīṣma) would be found to occur at the sun's entry into Aśvinī after about 4¼ thousand years, and the rainy season after about 8½ thousand years. The time interval between the sun's two coincidences with Aṣvinī star is known as the sidereal year. When the sun is near Aśvinī star, the moon is near about Citrā star on the full moon day, and hence, this lunar month comes to be known as Caitra. Hence, if the spring season is observed to occur in a lunar month known as Caitra (from Moon's proximity with the star Citrā on full moon day), the spring will be seen to commence some time in Caitra for 2150 years and then some time in Phālguna for another 2150 years and then in Māgha for another 2150 years. (Or in other words, the summer season will be seen to occur in Caitra after about 4¼ thousand years after the time when spring season used to occur in Citrā.) In short the month Caitra would maintain its position as the first month of spring for about 2000 years only.

* A detailed discussion of precessional motion and of sāyana system will be found in the second part. The consideration of such matters in this chapter are made on the assumption that the equinoctial point makes a revolution in about 26000 years.

We find the identity 'Caitra + Vaiśākha = Vasanta (spring) season' in almost all works. The moment of commencement of season receded after a long time after the above identity became established in practice, and that is why we come across 'Mīna + Meṣa = Vasanta ' or ' Phālguna + Caitra = Spring' in some later works, and some almanac makers follow this identity at present. In our times the spring season is actually found to occur in Māgha and Phālguna, but the definition 'Caitra + Vaiśākha = Vasanta season' still persists in popular minds. The names Madhu and Mādhava have association with seasons and not with nakṣatras ; still the long usage of the identity ' Caitra + Vaiśākha = Spring ' has made people wrongly to shift the association of Madhu from that of Spring season to the nakṣatra name and Caitra is now wrongly called as ' Madhumāsa '. When the time of commencement of spring receded from Caitra to Phālguna, the identity, 'Phālguna + Chaitra = Vasanta' came into use and we find this definition in some later works. But we do not find the identities 'Vaiśākha + Jyeṣṭha =Vasanta' and ' Caitra as the second month of Śiśira' in any of the older works, when it was a fact that, spring actually began one month earlier than Caitra (say, 2000 years before). This definitely points to the fact that the names Caitra etc. came into vogue in those times when the vernal equinox actually used to take place in Caitra ; and this hint can lead one to find the probable time. The spring season commences one month before the sun comes to equinox *i.e.* when the tropical longitude of the sun is 330° ; and in order that the corresponding month should be named as Nirayaṇa* Caitra, the longitude of Spica (Citrā) must be less than this by 6 signs or 180° *i.e.* = 330—180 = 150°. The tropical longitude of this star in 1850 A. D. was 6^s 21° *i.e.* 201° or in excess of 150° by 51°. The time for this advance= 51 × 72 = 3672 years. Hence, the time for spring to occur in Caitra must be 3672 — 1850 = 1822 B. C., and it can be inferred that the terms Caitra etc. must have come into vogue in this period. Now taking into consideration the fact that the spring season commences earlier in some provinces and later in others, the time when the terms Caitra etc came into use will be taken to be earlier than what is found above. In some provinces the spring commences about a month and a half before the sun comes to vernal equinox and not earlier. Adopting the condition of "1½ month earlier than equinoctial day" the time of Caitrādi system would come to be 2900 B.C. Again, the doubt as to when the spring season should be taken as begun, the different longitudinal values of nakṣatras, all these factors lead one to adopt 4000 B. S. as the uppermost limit for the possible year before which the terms Caitra etc. could not have come into vogue. The Vedāṅga Jyotiṣa contains Caitra etc. as the names of months ; its time has been shown to be about the year 1400 B. S. The Taittirīya Saṁhitā does not contain these names and the time of compilation of some of its parts has been shown to be about 3000 B. S. He who has understood the sacrificial procedure given by Taittirīya Saṃhitā and the units of time like seasons and months, will know that if these terms would have been in use in the time of Taittirīya Saṃhitā they must have entered the text at some place or the other. This argument will convince the reader that the terms were not current before the time 3000 B. S. There are several big volumes of Brāhmaṇic works (at least 4) which do not mention these terms, It is clear that these are of later date than Taittirīya Saṃhitā. After weighing all these facts the writer feels that the time when the names Caitra

* For the sake of convenience I call a solar month as sāyana and the sidereal month as nirayaṇa.

etc. came into vogue should be safely taken to be 2000 B. S. Those parts of Kausītakī, Śatapatha and Pañcaviṃśa Brāhmaṇas which mention these terms, must have been compiled between 2000 and 1500 B.S.

Commencement of the Year.

In the Rigveda Saṃhitā no actual statement is made that a particular season should be regarded as the first one, nor do we find any indication about it. The words Śarad, Hemanta and Vasanta (names of seasons) are themselves used in the sense of a 'Year' and hence there are grounds to believe that the year used to commence with these seasons ; but the words Grīṣma, Varṣā and Śiśira are not found used in the Rigveda Saṃhitā in the sense of a 'year'.

It has already been said (on page 63) before that the year used to commence with Spring season and Madhu month in the age when the Yajurveda Saṃhitā was composed and generally in the Vedic age. There is no clear statement in the Vedic works that the year began in other seasons, and it is the author's opinion that we do not come across any indcation to show that the year commenced with winter solstice. This was Prof. Tilak's view and this has been examined later on. In Vedāṅga Jyotiṣa time, the year no doubt commenced with W.S. ; however, in the time when Sūtra works and the Mahābhārata were compiled; the first season was Spring which consisted of Caitra and Vaisākha together. This shows that both these systems were in vogue after the Vedic times ; but the system of beginning the year with spring appears to be more prominently used, since the " W. S.-year beginning system" was prevalent only in Vedāṅga-Jyotiṣa age. Also, we find in later astronomical works (Siddhānta) that they have adopted the system of commencing the year with Caitra and they must have adopted this as the system in vogue just before the compilation of these works.

It has been pointed out before (on page 111) that we get references at two places in the Mahābhārata that the list of months begins with Mârgaśīrṣa. Al Berunī, a traveller with Mahmud of Ghazni, has recorded that they in Sind and other provinces commence the year with Mārgaśīrṣa*. This shows that the system of beginning the year with Mārgaśīrṣa must have remained in vogue in some provinces at least for some time. Let us examine the matter in detail.

The Kṛttikādi system came into vogue at about 3000 B.S.; and it seems that the Mārgaśīrṣa month used to be regarded as the first month in some provinces soon after. The star Mṛga (Orion) is knwon as "Āgrahāyaṇī ". It derives this meaning because "The year ('Hāyana') stood at the end (*agra*) of that nakṣatra-night." In the Vedic literature we do find the following quotation :—"P. Phalgunī is the last night of the year and U. Phalgunī is the first".† In the Vedic age, the months were lunar and hence the year clearly started with a lunar month ; hence, the above quotation indicates that P. Phalgunī formed the last nakṣatra of some lunar month and U. Phalgunī the first one of the next month. These are, therefore, the daily nakṣatras (lunar). This shows that the system of commencing a year on the next day of a lunar month which ended with 'Moon associated with Mṛgaśirṣa ' must have come into vogue and this (last) night came to be known as Āgrahāyaṇī. This must have belonged to the time when Mṛgaśirṣa was regarded

* See p. 8, Biruni, India Vol. II.

† Their references from Tai. Br. 1. 1. 2. are given later on.

as the first nakṣatra ; naturally, Kṛttikās took the place of Mṛgà and became the first nakṣatra. Hence, following the old tradition, people began to commence the year on the next day of the month in which the moon used to be full near Pleides, *i.e.* in the month of Mārgaśīrṣa, which was a lunar month belonging to Pūrṇimānta'-system. Even in these days, we know that the lunar month following a ' full moon with Kṛttikās' is known as Mārgaśīṛṣa. Following this analogy it may be argued that there must have been a time when the year used to commence on the next day of the night when the moon used to be full with Mṛgaśīrṣa ; but a difficulty comes in making this assumption. Such a month would be the lunar Pauṣa ; and we do not get any reference to show that a year ever commenced in Pauṣa. We do not see any reason for Mṛgaśīrṣa being regarded as the first nakṣatra, other than the occurrence of vernal equinox in that nakṣatra. The equinox used to occur in the month of Mārgaśīṛṣa about 4000 B.S. It has been pointed out that the system of naming months after nakṣatras had not come into vogue then; and that is why this particular month (now known as Mārgaśīrṣa) used to be Agrahāyaṇa or Āgrahāyaṇī, and the absence of any reference for a year commencing in Pauṣa is thus understandable. The writer sometimes feels, that the system of naming a lunar month commencing on the next day of "full moon with Kṛttikā" as Kārtika, that commencing on the next day of "full moon with Mṛgaśirṣa" as Mārgaśīrṣa, and so on, might have been in use ; but we do not have it so now, nor do we get any indication of such a system being in vogue before. The full moon day is always regarded as the last tithi of the 'Pūrṇimānta lunar month' or of the 'light half-month' and never used to belong to the latter month or the second half-month, as can be seen from a number of quotations in the Vedic literature ; and the same system is followed at present. Hence, the following definition can be proved on the basis of the quotation of Pāṇini (4.2.21) [*viz.* "*Sāsminpaurṇamāsīti saṃjñāyām*"]. The lunar month in which the moon becomes full on Kṛttikās to be known as Kārtika, and the month which would commence from the next day as Margaśīrṣa, since the moon would be found to be full near Mṛgaśīrṣa in that month. In short, it can be said that the system of commencing the year with Mārgaśirṣa must have come into vogue in some provinces after the Kṛttikādi system came into use (*i.e.* after 3000 B.S.).

According to Prof. Tilak*, the month Mārgaśīrṣa got the name 'Āgra hāyaṇik', not because it formed the first month of the year, but because of its association with the star 'Agrahāyaṇa', the derivation of this word being according to him that nakṣatra after which the year follows and the sun coming to which shows the equinox and the year begins. This meaning is of course acceptable to the author ; but Prof. Tilak assumes two things (or at least they are so understood), *viz.* (i) that the system of commencing a year in Mārgaśīrśa was not in vogue and (ii) that the year never began on the next day of that full moon night on which the moon conjuncted with Mṛgaśirṣa. Even without these assumptions, his interpretation of the word 'āgrahāyaṇa' can be justified. We come across actual quotations that Mārgaśīrṣa formed the first month of the year and this fact can not be denied. Similarly, it has been shown above, that it was not impossible for the year to have been commencing on the next day of the full moon with Mṛgaśīrṣa and that it actually did.

The Mārgasīrṣādi System

Āgrahāyaṇī has been given a synonym of Mṛgaśīrṣa nakṣatra in Amarakośa. The same word occurs in Pāṇinī at 3 places (4.2.22 ; 4.3.50 ; 5.4.110)

* See Orion, Ch IV.

and the month of Mārgaśīrṣa derives its name of Āgrahāyaṇik from the word Āgrahāyaṇī. (Pāṇinī 4.2.22) According to grammarians, the word Āgrahāyaṇī chiefly stands for the Mārgaśīrṣa full moon ; and even with this meaning, because ' Āgrahāyaṇī ' is the meaning of Mārgaśīrṣa, the Mṛgaśīrṣa nakṣatra must be associated with the moon on the Āgrahāyaṇī full moon day, and ' Āgrahāyaṇī ' has begun to be understood as that full moon day or the next day of which the year commenced. This shows that there was a system of commencing the year on the next day of the Mārgaśīrṣa Pūrṇimā, having the full moon near Āgrahāyaṇī (*i. e,.* Mṛgaśīrṣa) star. Such a month bears the mame ' Pauṣa ' by present astronomical system and by Pāṇinī's system also. It has been shown above that the system of year beginning in Mārgaśīrṣa came into vogue after 3000 B.S. Hence, the system of commencing a year on Pauṣa must be prior to this system *i.e.* more ancient than 3000 B.S.; but the phenomenon of Mṛgaśīrṣa star being on equator was an impossibility then ; the reason for the year commencing on Mārgaśīrṣa could not have been anything else than the occurrence of vernal equinox in Mṛgaśīrṣa star.

Mr. Bal Gangadhar Tilak wrote a book 'Orion ' in English in 1893 A.D. in which he has proved, from quotations in the Rigveda Saṃhitā, particularly the verse 1.163.3 and the stanza 10.86, that the vernal equinox used to take place in Mṛgaśīrṣa in Vedic times ; and many legends current in India, Persia and Greece are fully explained by assumming the truth of this phenomenon ; and the Mṛgādi-system suggests that the time of compilation of some verses in the Rigveda Saṃhitā must have been about 4000 B.S. which has been shown to be true from ' Āgrahāyaṇī ' being the name of Mṛgaśīrṣa.

Mr. Tilak has also shown that some Vedic references suggest that the equinox used to occur in Punarvasu. Although the references are not so clear or so many as in the case of Mṛgaśīrṣa, yet the phenomenon is not impossible to have occurred. The equinox used to be in Punarvasu before 6000 B.S. and some of the Vedic Sūtras could have been possibly compiled then.

Mr. Tilak argues from the stanza describing the annual sacrifice (samvatsara satra) that the phenomenon of W. S. happening on Citrā full moon and the Phalgunī full moon days leads one to infer that vernal equinoxes used to occur on Mṛga and Punarvasu respectively. But the fact that vernal equinox used to occur in Mṛga nakṣatra can be proved independently and does not require the support of the quotation *viz.* 'W.S. used to take place in Phālguna'. There are certain difficulties in not accepting these stanzas for consideration. The first one is that this fact is not stated therein explicitly. The second one is that the 'Phālgunī-Pūrṇimā ' has been said to be the commencing day of the year; similar ideas are found expressed in Taittirīya Śruti as gvien below :—

वसंते ब्राह्मणोऽग्निमादधीत ॥ वसंनो वै ब्राह्मणस्यर्तुः ॥ मुखं वा एतदृतुनां ॥६॥यद्वसंतः ॥ यो वसंतेग्निमाधत्ते ॥ मुख्य एब भवति ॥ ...न पूर्वयोःफल्गुन्योरग्निमादधीत ॥ एषा वै जघन्या रात्रिः संवत्सरस्य ॥ यत् पूर्वे फल्गुनी ॥...उत्तरयोरादधीत ॥ एषा वै प्रथमा रात्रिः संवत्सरस्य ॥ यदुत्तरे फल्गुनी ॥ मुखत एव संवत्सरस्याग्निमाधाय ॥ वसीयान् भवति ॥...॥८॥

तै. ब्रा. १. १. २.

"A Brahmin should 'establish fire' (*i.e.* commence the annual sacrifice) in Spring season, which is the (proper) season for a Brāhmaṇa, because it is the 'mouth' *i. e.* the first season of the year. Now, about Spring season. He who commences a sacrifice in Spring becomes a leader..............never

commence it on Pūrva Phalgunī, because it is the hindermost (*i. e.* last) night of the year.......... ....do commence it on the Uttara Phalgunī nakṣatra, as it is the first night of the year; one who 'establishes fire' in the beginning of a year, becomes wealthy."

According to this by the word 'Phalgunī' we have to understand the full moon night, the moon being conjoined with Phalgunī nakṣatra. At present the Phālguna-month of the 'Pūrṇimānta' system ends on the Phālgunī full moon day and Caitra begins on the next day. Similarly we find in the above lines, the Pūrva Phalgunī full moon day being mentioned as the last day of the year, and the next night as the 'mouth' (commencing night) of the new year, and the 'ādhāna' ceremony has been recommended for that day; and in the foregoing lines we find that 'ādhāna' ceremony has been ordained to take place on the same day, it being the beginning day of the Spring season. All these lines are given in the same stanza and must be correlated. This proves that the Phālgunī-full-moon day must have definite relation with Spring. The Āśvalāyana Śrauta Sūtra gives, in relation to annual sacrifice, the line (1. 2. 14. 3.)

अत ऊर्ध्वमिष्ट्यथनानि सांवत्सरिकाणि तेषां फाल्गुन्यां-पौर्णमास्यां चैत्र्यां वा प्रयोग:

"Those who desire to commence yearly or half-yearly sacrifices should make use of the full moon day of Phālguna or Caitra."

And in Āśvalāyana Sūtra the months of Phālguna and Caitra are related to Śiśira and Vasanta respectively; and the Hemanta season is bound to commence with W. S.; but nowhere do we find any relation of Phālguna with Hemanta. In some provinces the spring season is taken to begin even two months before the sun comes to the equinox; and on this basis, the commencement of spring season with Caitrī Pūrṇimā must be taken to happen about 4000 B. C., and the spring season can be seen to take place in the same particular month for 2000 years and hence the commencement of spring with Phālgunī Pūrṇimā must be taking place about 2000 B. C. and the idea of introducing the system of commencing the year at this very moment could have struck people's mind and no discrepancy is so far noticed in our reasoning. The Viṣuvān day used to occupy the central place in the Samvatsara-Satra (annual sacrifice); but the word 'Viṣuvān' does not appear necessarily to mean that day on which the day and night are of equal length. The year has been described as commencing on a full moon day; and once it is assumed that the central day should be one equinoctial day, it follows that the commencing day also must be another equinoctial day (within a limit of two days); and in order to satisfy this condition, it will be seen that the year cannot be made to begin on a full moon day. For, supposing a certain full moon day (being the commencing day of a year) was an equinoctial day; then the next equinoctial day would be the 11th day after the full moon day and the 3rd one, the 22nd day and so on. This shows that the word 'Viṣuvān' used to mean in the beginning the 'central day of an annual sacrifice or of any other sacrifice' and this was particularly true about the Taittirīya Saṃhitā; and as time went on, the term perhaps used to be applied to the equinoctial day and the year began on such day, and that is why the formula for finding out the Viṣuvān day has been given by Vedāṅga Jyotiṣa. Even according to Mr. Tilak's belief, the Viṣuvān day of 12 hours' (30 ghaṭis) length, does not occur in the middle of an annual sacrifice, but at the end of the 3rd and

9th months. It has been shown above, that there is no ground for any one to suspect that in the times when the stanza describing the annual sacrifice in the Taittirīya Saṃhitā was compiled, the Viṣuvān (of the meaning of an equinox) used to occur in Phālguna.

The Limits of Vedic Age

The lower limit of the Vedic age can be roughly estimated on the basis of the fore-going discussion. But who would be able to fix up the upper limit? It can only be said that it can not be later than the year 6000 B.S. No one can say as to when the Vaidic mantras evolved in the human mind and in one sense the Vedas can be said to be 'Anādi' *i.e.* without a beginning. The lower limit of the Vedic age is about the year 1500 B.S. This is followed by Vedāṅga Jyotiṣa. The Saṃhitās (*i.e.* collections of mantras) of all the Vedas, Brāhmaṇas and some of the Upaniṣads have been compiled during this period. Some Upaniṣads might have been compiled even during Vedāṅga Jyotiṣa period ; but the lower limit of the Vedic age has already been given above. A part of the Rigveda Saṃhitā belongs to 4000 B.S. The Taittirīya Saṃhitā belongs to 3000 B.S. The Brāhmaṇas were compiled between 3000 to 1500 B.S. Those of them which contain terms like 'Caitra and others' were compiled later than 2000 B.S., while others were compiled earlier. Nothing definite can be said about the Upaniṣads ; but many of them were compiled between 2000 to 1500 B.S. It is not that the mantras of the Saṃhitā and Brāhmaṇa were compiled in the same time in the form in which they appear to us to-day, still it can be said that they emerged in their complete form before 1500 B.S.

Prof. Max Muller has thus attempted to fix up the period of the Vedic age :—"Lord Buddha attained 'Nirvāṇa' in the year 477 B.C. The Bauddha religion had its beginning about 100 years before this. The Vedic works were completely compiled till 600 B.C. They appear to belong to 3 periods —Sūtra, Brāhmaṇa and Mantra, the Sūtra period ranging from 600 to 800 B.C., the Brāhmaṇa period 800 to 1000 B.C.; and the Mantras of all Maṇdalas (sections) of the Rigveda were compiled in an earlier period." It is his opinion* that no human being will be able to say whether the Rigveda Sūtras were compiled in 1000, 1500, 2000 or 3000 years B.C. and Europeans accept this view. These inferences are based only on history and philology. Taking into consideration this fact and also the assumption of a period of only 200 years for each Vedic subperiod, the author feels that the limits fixed above, on the basis of astronomical evidences should be accepted as correct.

The Limits of Vedāṅga Period

1500 B. S. is the upper limit of the Vedāṅgas. The lower limit can be fixed up after examining the problem as to when the 7 week days and Meṣādi signs came into vogue. The names of seven week days are not found in the Vedic literature. Of the remaining ancient works, references of week days are found in none except in Atharva Jyotiṣa and Yājñavalkya Smṛti ; and references to Meṣa and others are found in none other than Baudhāyana Sūtra.

It is needless to say that both are mentioned in Sūrya Siddhānta and other such works. Even if it be supposed that both of them are products of Indian mind, they, at least, did not belong to the Vedic period.

*Physical Religion, pp. 91-96 (1891 A.D.).

The order of names for the 7 week-days is as follows :

If the planets be regarded as revolving round the earth, they can be written in their order as Saturn, Jupiter, Mars, Sun, Venus, Mercury and Moon. It is assumed that the day is divided into 24 hours (Horā) and these horās are controlled by these seven planets in this very order. These planets get the lordship of the horās thrice in a day and 3 more horās remain. Hence, the lordship of the 1st horā at sunrise passes on to the 4th planet. If, for example, the lord of the first hour on the first day be Saturn (then last 3 hours will be controlled by Saturn, Jupiter & Mars) and Sun will be the lord of the first hour on the next day ; and following the convention that Lord of the first hour to be reckoned as the lord of the whole day, if Saturn be the Lord of the first day, the Sun becomes Lord of the second and hence, Saturday is followed by Sunday. Thus we get the usual order of names of week days. It should be noted that the next day bears the name of every 4th planet from the previous one. The Sūrya Siddhānta observes as follows about it :—

मंदादधः क्रमेण स्युश्चतुर्था दिवसाधिपाः ॥७८॥
होरेशाः सुर्यतनयादधोधः क्रमशस्तथा ॥७८॥

भूगोलाध्याय.

"The Lords of days are to be reckoned in order fourth from Saturn downwards. The lords of hours also are to be reckoned commencing from Saturn downwards."

Even Āryabhaṭa says that the lords of days are to be taken as '4th from the previous one' "*Sīghra Kramāt caturthāḥ dinapāḥ*" (Kal Kri. 16).

The system of dividing a day into 24 parts called 'horā' is true only in consideration with the theory of week days and astrology. The astronomical works, Siddhāntas, do enumerate time-units but they do not mention 'horā' as one of them, and no work belonging to Vedic and Vedāṅga period ever mentions it. This word is not Sanskrit in origin. Varāhamihira has attempted to justify its Sanskrit origin by explaining that the word is 'coined' by taking the middle portion of the word *Ahorātra*, leaving out 'A' and 'Tra', but this explanation is not satisfactory. The Chaldeans had this unit in use since a long time and they did have a week of seven days as at present. Considering this the author feels that 'Week-days' do not belong to us but have been borrowed from Chaldeans.

It has been shown under the topics of Vedāṅga Jyotiṣa and the Mahābhārata that the terms Meṣa and others are Sanskrit and it can not be said for certain that the system of dividing the ecliptic into 12 parts did not originally belong to us. Even from Vedic works we find that people did conceive the idea of giving to asterisms names similar to some well known shapes. We can not, therefore, say for certain that the Meṣādi signs are not ours. These terms, however, do not belong to Vedic or Vedāṅga Jyotiṣa period, which means that these were not in use before 1500 B.S. Now looking to the history of other nations, some say that these were known to Egyptians before 2160 B.C. and according to others even before 3285 B.C. Some are of opinion that Chaldeans knew both Vāra and Rāśis before 3800 B.C. In any case, it can be said for certain that both these nations knew the terms before 1000 B.C. and Mr. Laing writes emphatically that the 'Vāras' were known to Chaldeans long before 3800 B. C.*

* See Proctor Lockair's English book "Ninteenth Century" and his article in the July T892 issue, page 34 ; also see S. Laing's Human Origins, Chap. V. pp. 144-158.

It can be seen from Vedāṅga Jyotiṣa that both of these were unknown in our country before 1500 B.S.

It is a matter of controversy if the terms Meṣa and others originated with shapes of clusters of stars. There does not appear to be any relation between their shape and name, irrespective of the consideration whether these belonged to Indians or have been borrowed. We do not get the form of a ram (Meṣa) from the clusters of stars of Aśvinī, Bharaṇī and some stars from Kṛttikā. Meṣa happens to be first in order of signs and begins from Aśvinī. Just as we have a definite reference of a Kṛttikādi system having been in vogue before the Aśvinyādi system, we do not find any reference by which it can be said that the order of Rāśis began from a sign other than Meṣa or the Meṣa sign began from a nakṣatra other than Aśvinī ; and there is no doubt that these terms were not current in the Vedāṅga period. Hence, it can be easily inferred that these terms came into vogue at a time when the vernal equinox occured in Aśvinī nakṣatra and Meṣa sign simultaneously. The tropical longitude of the star Beta Arietis was 31° 53′ and that of Alpha Arietis 35° 34′ in 1850 A.D. Hence, the years when the longitudes of these stars were zero come to be 31° 53′×72 (= 2296)—1850 = 446 B. C. and 35° 34′ × 72(= 2561)—1850 = 711 B. C. It is, therefore, impossible that the terms Meṣa etc. were known in our country before these dates, the mean of these dates being 579 B. C. Another important fact is that the time when Śravaṇādi system described by the Mahābhārata came in vogue, has been proved to be about 450 B.C. (See page 110), and the Mahābhārata does not contain any reference about Meṣādi terms ; hence, it can be safely inferred that these terms were unknown in our country before 500 B. S. It will be shown in Part Two that some of the Siddhāntic works like the old Sūrya-Siddhānta do not belong to a date later than 200 B. C. They do contain the terms Meṣa and others ; similarly it can be proved beyond doubt that some of the astronomical (Siddhānta) works were compiled earlier than this date. All these considerations lead one to infer that the *Meṣādi terms were introduced in our country about 500 B.S.* and *the week-day names came into use 500 years before this date.* It has already been pointed out that suggesting a system of Rāśis (Meṣa and others) and of week days is not a matter of much importance; what is very important is the calculation of actual positions and motions of planets (See page 108).

In short, the *lower limit of the Vedāṅga period comes to be 500 B.S.*

All those original works which contain the Caitrādi terms but neither the Vāra or Rāśi names, must be taken to belong to the Vedāṅga period, since these two must have got entry into them, had these been current in Vedāṅga Jyotiṣa period. The works on astronomy and religion belong to this category, and naturally the 'Kalpa Sūtras' and 'Smṛti's come to belong to this category. All works described in Part One, excepting Baudhāyana Sūtra, belong to the Vedāṅga period ; and there is no harm if we say that, of these works, those which do not contain any reference of week days, were compiled earlier than 1000 B.S. The date of compilation of each particular work must be decided after considering the work independently. Fresh additions have been made in the text of the Mahābhārata from time to time till 500 B.S. ; the matter of Śravaṇādi system lends a support to this view. Some more interpolations might have been made even after this date ; but some portions of the work are very ancient. The astronomical description of the planetary positions definitely points to the age in which Pāṇḍavas ved. This is the author's view.

The lower limit of the Vedāṅga period is the upper limit of the Jyotiṣa Siddhānta period.

It is needless to say that the limits of the Vedic and the Vedāṅga age as fixed by the author are not very accurate. The ancient history and ancient literature are still matters of research and the above limits are likely to change when the research is made. The author is, however, certain that the lower limit for the Vedic period can not be later than 1500 B.S. and that of Vedāṅga period not later than 200 B.S.

IN VEDIC AGE THE YEAR WAS SEASONAL *I.E.* SOLAR.

The so far made discussion must have made it clear that excepting the last few centuries, the year was strictly seasonal or solar throughout the Vedic age. The months were lunar and adjustment to solar year used to be made by interpolating an intercalary month at a suitable place. We find in the Ṛk-Saṃhitā the names of seasons like Śarad, Hemanta etc. used in the sense of a year. This shows that one complete cycle of seasons formed the measure of a year and such a system of maintaining the measure of a year was followed in the Rigveda Saṃhitā age. The lines like :—

ऋतुभिर्हि संवत्सरः शक्नोति स्थातुं
श. ब्रा. ६. ७. १. १८.

"A year can stand only with the help of seasons" indicates the same idea. The derived meaning of the word "Saṃvatsara" is "Saṃvasanti ṛtavaḥ yatra" *i.e.* year is that period in which the seasons stand completely. These quotations clearly support the view that in Vedic times, by the term year was understood a period of one complete revolution of seasons.

Madhu and Mādhava were the months of a year (Saṃvatsara). These indicate seasons. The importance of these months in the Yajurveda Saṃhitā and in all Brāhmaṇa works will be clear from the divine status which these months received. It will also be seen from the terms Aruṇa and others that they are associated with seasons and not with nakṣatras. The names of months current in the major portion of the Vedic age were Madhu and others; the Caitrādi names got introduction in the last period of the age. These names got their association with the nakṣatras and hence, the year calculated on this basis must have been sidereal. It appears from this, that the sidereal year came into use about 2000 B.S., when the Caitrādi names associated with nakṣatras came into vogue ; and before this time, people could carry on their affairs with Madhu-Mādhava months and hence it is proved that the year was seasonal (*i.e.* tropical). Some people might argue that the Caitrādi names must have come into vogue not much later than the Madhvādi name system. But it has been shown (pp.30-31) that there were difficulties for the introduction of Caitrādi names after the nakṣatras got their names and that much time must have elapsed in between. Even without any other support it can be shown that the very fact that Madhvādi names have a divine status in the Vedas and not the Caitrādi, is sufficient for one to infer that a number of centuries must have elapsed before Caitrādi names became current. The nakṣatra occupied by the sun is never visible ; hence it is but natural that the seasonal year came into vogue earlier than the sidereal year which is the interval between the sun's two consecutive coincidences with the same star. Now when the author says that the solar year came into use first and not the sidereal one, it should not be taken to mean that a correct tropical year came into are after the actual difference between the lengths of the two years occame

known after studying the precessional motion of equinoxes. They in the Vedic age had the system of interpolating an intercalary month at the proper place so as to maintain the correct relation of lunar months with the seasons, so that the months of Madhu and Mādhava would on average be found to occur in the spring season. Even when a ' fixed year ' came into vogue in the latter part of the Vedic age, the year was to commence with W. S. as ordained by Vedāṅga Jyotiṣa, and other works recommended the commencement of a year with spring. From this, it is clear that their object was throughout that of following a seasonal year and they never dreamt that they are not following a tropical year system just as we in the present time do not suspect the change. Even if Mr. Tilak's argument be accepted that in Vedic times year commenced from W. S., the commencement of a year with a solstice is nothing else than following a seasonal year, and the year proves to be tropical and not a sidereal (or fixed) one. In short, we find that the seasonal year was in long use before the fixed year and from historical point of view the tropical year was acceptable to 'Śrutis' and it was a natural one. Spring has been described as the 'mouth' of a year, Madhu and Mādhava as months of the spring season and the Madhvādi names were current. All these things can not remain true without following a tropical year. The seasons will not be found to occur in the same months by following the nakṣatra-month-system, and an idea of their departure from the usual position is already given on page 132. From this it is proved that it was the tropical year which was acceptable to Śrutis.

THE YUGA SYSTEM

Almost all aspects of the Yuga-system have been discussed in the preface. According to Āryabhaṭa II, Mercury was behind the sun by about 9° in the beginning of the present Kaliyuga. According to the Sūrya-Siddhānta and Āryabhaṭa I the longitude of the moon's Apogee was 90° and that of its Node 180° ; but Brahmagupta and Āryabhaṭa II quote different values for them.

While examining the works of the Manu Smṛti and the Mahābhārata it has been shown that the measures of time units, yugas etc., as given by astronomical (Siddhānta) works, were already defined and fixed. These works are said to give as a criterion of the commencement of yuga the condition that all planets must come together in the beginning of Kaliyuga and of each other Yuga. . (According to some other works all planets come to a close conjunction at the beginning of a Kalpa and come together within a reasonable proximity in that of a Mahāyuga). This criterion or condition is neither found in these works or in any of the works discussed before. On the contrary we find in the Mahābhārata the condition for starting a Kṛtayuga, to be "the coming together of the sun, Jupiter, the moon and the Tiṣya (Puṣya) star" (Vana Parva, 190.90/91). Similarly according to the astronomical works, the Kaliyuga started in the year 3179 B.S. But we do not find in any later works an explicit or implicit mention of this yuga having been so started. No reference to this age or to a criterion of the commencement is found in any of the Purāṇas and the above mentioned condition also is not well known.

The current year Śaka 1817 is the 4996th year of Kali elapsed. It shows that so many years have elapsed after the commencement of the Kali era. This era, according to the Sūrya Siddhānta, commenced on Thursday at midnight when it was the mean Amāvasyā of Phālguna. According to some other Siddhāntas it commenced after 15 ghaṭis more, that is on Friday morning. Prof. Whitney has, in his translation of the Sūrya-Siddhānta in English

calculated mean positions of planets by accurate European formulae true for the midnight of Thursday, the 17th February 3102 B. C. (Julian period) which is the moment of commencement of Kali. The author has given in the following table these positions and also those calculated by him with the help of Astronomical Tables by Prof. Keropant Chhatre. These tables have been prepared by him with the help of European books on astronomy, and Prof. Whitney has calculated the figures with the help of these European books. The true places of planets at the beginning of Kali as calculated by the Sūrya Siddhānta formulae are also given in a separate column. The author has also given in another column planets' true places, the calculations of which have been based on Whitney's mean places, and taking nodes and perihelions from Keropant's tables. The European tables are proved to be very accurate in modern times and their calculations are verifiable by actual observations of planets in the sky. If these tables are followed, the positions of planets 5000 years ago must be found to be tolerably accurate, if not quite correct.

Places of planets in the beginning of Kali

	Sāyana mean longitudes						True positions					
	According to Whitney			According to Chhatre's tables			European (Sāyana)			According to Sūrya Siddhānta		
Sun	301°	45′	43″	301°	13′	42″	303°	35′	42″	2°	07′	27″
Moon	308	03	50	301	36	18	312	15	30	5	02	46
Moon's Perigee	44	56	42	67	32	42				90	00	00
Moon's Node	148	02	16	145	00	00	147	53	34	180	00	00
Mercury	268	34	05	267	36	42	288	03	54	358	07	27
Venus	334	36	30	333	45	24	316	12	06	0	52	12
Mars	289	48	05	289	11	18	300	34	18	5	42	30
Jupiter	318	16	07	318	04	06	317	45	54	0	42	00
Saturn	281	36	18	280	02	18	278	00	18	353	24	57

The author has not applied the (कालांतर) time correction to the mean positions of planets calculated by him by Keropant's tables. Keropant has mentioned a "Kālāntar" [time] correction to be given only to the sun, moon, moon's perigee and moon's node. If it be applied to them they would agree with the places given by Whitney; and other planets, even when no "Kālāntar" (time) correction be given to them agree wtih Whitney's places. This shows that Whitney has not given this correction to the five planets, Mercury and others.

The mean longitudes of all planets except Rāhu (moon's ascending node) are zero, according to the Sūrya Siddhānta. The European positions of planets are Sāyana and those of the S. S. are Nirayaṇa. The measure of the error of our astronomical works is equal to the excess or deficit of the difference between sāyana sun and any sāyana planet and that between the longitudes of the sun and the corresponding planet according to the S. S.

We find that the sun's place according to Whitney is in advance of Mercury by about 33° and Venus is in advance of the sun by about 32°. If, therefore, the European tables are correct the error in the mean places of planets calculated according to our works should be taken to be equal to the planetary differences.

The planets in the sky are observed to occupy the calculated true places and not their mean places. A glance at the places calculated by European tables shows that the maximum distance between the sun and other planet is that of Saturn (25°) behind and of Jupiter (14°) in advance. According to the Sūrya Siddhānta all planets are within 9 degrees of the sun and are therefore 'invisible' and there appears to have occurred a solar eclipse on Thursday, it being an Amāvasyā day. According to European calculation only Mars seems to be invisible in the sun's rays. If Rāhu's figure, according to Whitney, were taken 15° less, then there is a solar eclipse. Taking the longitude of Mercury 10° more, of Venus 9° less, of Jupiter 4° less and that of Saturn by 11° more, we get the following figures for true places of planets, showing that all planets are heliacally set :—

Sun	303°	35′	42″	Jupiter	315°	06′	36″
Mercury	290°	40′	06″	Saturn	288°	17′	30″
Venus	312°	28′	48″				

In brief, according to our astronomical works, all planets were together in the beginning of Kaliyuga, but the fact is otherwise. It may be that all planets were heliacally set, but we do not get even such a description in the Mahābhārata and other works. At least 2600 years elapsed after Kaliyuga till the Sūrya Siddhānta and other works were compiled, and the Yuga system described by the Manu Smṛti was in vogue before these works ; but it does not seem to have been proved that Kaliyuga actually started at such particular time. The quotation from the Rig-Yajurveda *viz.* "the herbs which grew in three yugas before" has already been given on page 12. The fact that Kaliyuga commenced in the year 3179 B. S. was established beyond doubt in the Vedic and Vedāṅga Jyotiṣa age, is not proved from this quotation. Hence, there are grounds for suspicion that the astronomers fixed up that moment as the beginning of Kaliyuga at which all planets were found to be together, starting backward calculation from the year of compilation of the astronomical work.

ROHIṆĪ ŚAKAṬA BHEDA

The Rohiṇī constellation consists of 5 stars ; these together form the shape of a cart and hence, the group of stars is known as 'Rohiṇī Śakaṭa'. Of these 5 stars the latitude of the northernmost star (Epsilon Tauri) is 2° 34′ 43″S and that of the junction star is 5° 28′ S ; and when a planet while passing through this constellation possesses a latitude lying between the two figures, it is said to be piercing the 'cart'. The value of a planet's latitude depends upon its node. The moon's mode makes a complete revolution of the heavens in about 18 years during which the moon is able to pass through the constellation for 5 or 6 years only. It was pointed out on page 31 that the moon generally used to pass through Rohiṇī constellation from September 1884 to March 1888. The conjunction of the moon with Rohinī star has remained an object of interest since very ancient time. The story of the Moon's love with Rohinī is very famous in the Purāṇas. The whole* paragraph No. 5 (in Chapter

* There is a detailed description of this conjunction (and translation of the paragraph also) given in chapter 'Rajanī Vallabha' in the book "Jyotirvilasa" (See page 52, second edition.)

3, 2nd Aṣṭaka of Taittirīya Saṃhitā) contains stories about the moon's special attachment with Rohiṇī, who was one of the 33 Prajāpati's daughters given in marriage to him. These 33 daughters are the 27 stars from 27 Nakṣatras and six stars from Kṛttikā group. It is evident that the story originated from the often observed conjunction of the moon with this star. This conjunction and its effects are described in detail in Garga and others' Saṃhitās; and we find that whole chapter No. 24 in Bṛhat Saṃhitā is devoted to the topic of "Moon's conjunction with Rohiṇī ".

It is well known from the astronomical works that the piercing of the constellation of Rohiṇī by Saturn and Mars indicates disaster in the world. Varāhamihira says,

रोहिणीशकटमर्कनंदनो यदि भिनत्ति रुधिरोथवा शशी ॥
किं वदामि यदि नष्टसागरे जगदशेषमुपयाति संक्षयं ॥ ३५ ॥

बृ. सं. ३४.

"If the Rohiṇī constellation is crossed through by Saturn, Mars or the Moon, I will not be surprised if the whole world completely plunges into the ocean of disaster and gets ruined."

Gaṇeśa Daivajña, the author of Graha Lāghava, says,

भौमार्क्यो: शकटभिदा युगांतरे स्यात् ॥

ग्र. ला. ११. १२.

"The piercing of Rohiṇī-cart by Saturn or Mars is a phenomenon rarely to occur after interval of yugas".

In the present times when Saturn approaches Rohiṇī, its maximum latitude becomes 1° 50′ South and that of Mars, about 12′ North ; hence, neither of them pierces the cart. Then how could descriptions of disasters due to their passing through the constellation get into astrological works ? It is not that such a phenomenon is an impossibility. We know that Jupiter's south latitude never attains a value of 2° 35′, and we do not read of the piercing of Rohiṇī by Jupiter in the astrological works ; but this is not the case with Saturn and Mars. The maximum value of Saturn's south latitude is 2° 45′, and that of Mars is 2° 53′. These planets, therefore, do come within the range of 'Rohiṇī cart', some time during the revolution of their nodes in the sky. These revolutions take about 40 to 50 thousand years and some time during this period, these planets must have passed through the constellation of Rohiṇī. While attempting to calculate possible years for Saturn the author finds that the crossings by these planets have never occurred after the commencement of Śaka era ; not only this, it never occurred during 5000 years before Śaka era. He found that in the year 5294 B.S. the tropical longitude of the northernmost star of Rohiṇī was 10^s 28° 2′ and when Saturn came to that position, its south latitude was 2° 34′. From this,* it appears that near about this year and during a number of years before this, Saturn used to pierce the cart in each round. The time of piercing the cart by Mars appears to be much earlier. The Saṃhitā works describe the effects of Śakaṭabheda by Saturn and Mars and since this crossing did not occur later than 5000 years B.S., it is proved that people in India had acquired knowledge of planets and their motions 5000 years before Śaka era.

* Calculations have been made from Prof. Chhatre's 'Table of planetary calculation'. The details of calculation are not given here for want of space.

It is evident that people had acquired knowledge of stars even before this, and this lends a support to our views expressed about the times of the Vedic period and that of compilation of the Ṛk-Saṃhitā.

KṚTTIKĀDI SYSTEM

कत्तिकाः प्रथमं ॥ बिशाखे उत्तमं ॥ तानि देवनक्षत्राणि ॥

अनुराधाः प्रथमं ॥ अपभरणीरुत्तमं ॥ तानि यमनक्षत्राणि ॥

यानि देवनक्षत्राणि ॥ तानि दक्षिणेन परियंति ॥

यानि यमनक्षत्राणि ॥ ७ ॥ तान्युत्तरेण ॥

तै. ब्रा. १. ५. २.

"Kṛttikās are the first and Viśākhā the last ; these constitute Divine nakṣatras : Anurādhā is the first and Apabharaṇī the last ; these constitute Yama nakṣatras : The divine stars turn from South (to North) and the Yama nakṣatras from North (to South)".

The bracketted words are not given in the original text ; but Mādhavācārya, the commentator of the Vedas has rendered the word ' dakṣiṇena ' as ' from south to north ' in the following lines in the Taittirīya Saṃhitā (*See* Chapter on 'ayana' by Kāla Mādhava).

तस्मादादित्यः षण्मासो दक्षिणेनैति षडुत्तरेण ॥

तै. सं. ६. ५. ३.

"The sun goes by the south for six months and for six months by the north."

The word ' dakṣiṇena ' can mean "to the south of a certain object" ; but no mention of a second object has been made in the sentence. If the divine stars be taken to be situated to the south of the ecliptic and the others to its north, it is an impossibility ; because, Kṛttikās lie to the north of the ecliptic, the next 3 constellations are situated to its south, and the next 2 are again found to lie to the north ; the stars are thus irregularly situated and the latitudes of the stars will never change (they might vary only by a minute or two of an arc in thousands of years). Hence, the description can not be said to be with reference to the ecliptic. Similarly it can not happen that all ' Kṛttikādi' groups be found to be situated to the south of the equator and others to the north. The declination of stars always changes due to the precession of equinoxes, *i.e.* their position, north or south of the equator changes. But because the latitudes of some stars like Arcturus (Svātī), Altair (Śravaṇa), Delphini (Dhaniṣṭhā), Alpha-Andromeda. (Uttarabhādrapadā) are greater than 24°, these stars will never be found to lie to the south of the equator*. Hence, none of 13 consecutive constellations will be found to lie to any one side of the equator. If an observer stands at any place on the earth, he will not find half the number of constellations moving from the northern side and half from the southern. Hence, the line ' dakṣiṇena pariyanti' can not be rendered as ' to the south of any particular object'. If we translate the above lines as " the Kṛttikādi stars move from South to North ", the sum total of the argument becomes that these are found to be situated in the sun's path when it moves from south to north. This leads one to

* I have attempted to find the positions of stars in 2350 B.C., 1462 B.C., 570 A.D. and 1887 A.D., but I never found that 13 consecutive constellations were on the same side of the equator. The calculations can not be given for want of space.—*Author.*

accept that the winter solstice used to occur on Kṛttikā, and the time for the occurence of the W. S. there comes to be 8750 B. C. But there are certain difficulties in translating the lines in this way. The Śatapatha Brāhmaṇa definitely quotes the position of Kṛttikās as " rising to the East". If the above meaning be taken to be correct, the difference in the times of Śatapatha and Taittirīya Brāhmaṇas comes to be about 6000 years, which is not possible and since we get a definite reference of the W. S. occurring on Dhaniṣṭhās we should naturally expect to get references of the W. S. occurring on the intermediate 6 nakṣatras ; but we do not get this in any of the ancient works. It is also true that the star-lore was known to our people in such an ancient period is not an impossibility, as can be seen from the discussion of the topic of "piercing of Rohiṇī-cart". It is not still clear what these lines really mean.

THE BRIEF SUMMARY

So far has been described in detail the astronomical knowledge which people obtained during the Vedic and Vedāṅga Jyotiṣa periods. The association of Greek astronomy with that of Indian, if it was formed at all, belongs to the later period. The whole knowledge described in this part has been independently obtained by the people of our country. The author describes in brief some special information chiefly related to their knowledge of motions and positions of planets. Other important things can be referred to the places where they have already been discussed in detail.

People possessed knowledge about stars before 5000 B.S. The system of adding an intercalary month must have been introduced in those days. The months were lunar. They had obtained some knowledge about planets. This should not be taken to mean that they were able to predict planetary positions for the future. They found that planets have motion and they had begun to observe their positions with respect to stars. The months were then probably called by Madhu, Mādhava etc. Caitra and other names of months came into vogue at about 2000 years B. S. and till that time the year used to be tropical. Later on, it became sidereal in form because of introduction of ' Caitrādi' names for months, but in principle the year was no doubt tropical.

The time of Śatapatha Brāhmaṇa, from the references about Kṛttikās in it, comes to be 3000 B.S. and the Vedic Saṃhitā undoubtedly belongs to an earlier period.

The time of Vedāṅga Jyotiṣa has been proved to be about 1500 B.S. In those days, the measure of the day was 60 ghaṭikās. The mean motions of the sun and the moon were tolerably accurate. The measure of the solar year was erroneous ; still, that kind of solar year was in vogue. Not only the system of adding an intercalary month to bring agreement of the lunar year to the solar one was in use, but the year was divided into 12 solar months. The concept of the system of the Ecliptic being divided into 12 parts, each part being divided into 30 divisions, and each such division subdivided into 60 parts, had taken root during this period ; and an important thing *viz*. introducing similar units for time divisions and area divisions came into practice. There are sufficient grounds to believe that the division of a circle into Rāśis, degrees, minutes and seconds is the result of Hindu-imagination. It seems that people had acquired knowledge of mean motions and positions of planets by the end of the Vedāṅga period.

The next important step is the knowledge of true positions and motions of planets. It has been shown under discussion on the topic of '13-day half-month' that people had acquired working knowledge of calculating true positions of the sun and the moon. It is more difficult to understand and calculate the true positions of planets than those of the sun and the moon. No definite proofs are known for the confirmation of this. But the fact that the retrograde and direct motions of planets used to be a topic of their discussion, leads one to believe that people had come to know that the true positions are not regular like the mean positions, and hence it can be conjectured that they had probably begun to deliberate upon the aspect of true motions of planets. We find a mention of solar months in the Vedāṅga Jyotiṣa period. We come across names of Saṃkrāntis as Ayana, Viṣuva, Ṣaḍaśīti, etc. From this it can be said that the system of dividing the ecliptic into 12 parts had come into vogue in the Vedāṅga Jyotiṣa period or very soon afterwards but the positions of planets are found to have been mentioned with respect to nakṣatras. This shows that the system of indicating planetary places in terms of 12 Rāśis had not come into vogue then.

The names of Rāśis (Meṣa and others) came into vogue at about 500 B.S. The names of week days came into use before then, and have been borrowed from foreign countries.

The system of reckoning a Mahāyuga as equivalent to 4320000 years must have come into vogue in a period earlier than Yāska.

The Atharva Jyotiṣa shows that astrology came into existence into our country quite independently.

In short, the origin of the knowledge of calculation of the true places of planets and that of predicting their effects (*i.e.* astrology) had taken root at the end of the Vedāṅga Jyotiṣa period. The process by which that knowledge gradually developed into the form of treatises will be discussed in detail in the second part.

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